Chapter 1
Purpose and Need of the Proposed Action

1.1 Introduction

The CR Kendall site is located in the eastern flanks of the North Moccasin Mountains in Fergus County, Montana (Figure 1-1). The mine site is located 8 miles west of Hilger and 25 miles north of Lewistown.

1.2 Site History

Mining in the area can be divided into the historical period from 1880 through 1941 and the modern period, extending from 1981 through 1997. A thorough treatment of the mining history at the site, including vintage photographs and maps can be found in the report *Effects of Historic and Modern Mining on Sediment and Water Quality in the Off-Site Mine Area Drainages* (CDM, 2004b).

1.2.1 Historic Mining

Add brief description of mineralization; 1-2 paragraphs at most

Deleted: and in chapter 3

Mining began in the North Moccasin Mining district in 1880, when "Old Man" McClure staked a claim in what was to become McClure Gulch, about 2 miles west of the modern mining operations on the west slope of the Moccasin Mountains. In 1881, the Buchanon Brothers and John Brooks established a claim in Iron Gulch (about 1.5 miles west of the modern mining operations). The operations were believed to have been largely placer mines, although an unsuccessful stamp mill was constructed in 1898 (Montana Historical Society (MHS) 1974). The nature of the lode ore prevented economical gold extraction using free milling techniques such as employed when crushing the ore in a stamp mill and amalgamating the gold using mercury. Therefore, it is likely that only a very small quantity of tailings was produced from the Iron Gulch mill before the experiment was abandoned.

Placer operations continued in the drainages west of the current mine site through the 1930s and possibly later. Estimates of the placer gold production from Iron Gulch, McClure Gulch, Bed Rock Creek and Plum Creek range from $10,000 to $50,000 between 1880 and 1933 (Blixt 1933). Given the low production figures, the mass of tailings produced from the placer operations is believed to be small. No tailings are visible on the air photos of this area.

Three cyanide mills were in operation in the district between 1900 and 1941:

- Kendall Mill (1900-1912)
- Barnes-King Mill (1901-1923)
- North Moccasin Syndicate Mill (1936-1941)

With the advent of the cyanidization process in the 1890s, the economical extraction of gold from the lode ore in the North Moccasins became possible. The cyanidization process involved four steps: crushing, leaching, precipitation, and refining. The mined ore was crushed to

Figure 1-1

Change “Kendall Project Area” to “CR Kendall Project Area”

¼-inch mesh and placed in a vat of cyanide solution (3 pounds potassium cyanide per ton of water). Gold recoveries of 90 percent were obtained from the oxidized ore. The unoxidized ore and black ore containing bituminous and organic matter were roasted before leaching to convert the gold into a form that could be dissolved by the cyanide solution.

Following leaching, the cyanide solution containing the gold was pumped to the precipitating tanks, which contained zinc shavings. The surfaces of the zinc particles then became plated with gold. The gold-plated zinc was then placed in a lead-lined tank where sulfuric acid was added to dissolve the zinc, leaving the gold as a thick, black mud-like material. The gold mud was then refined into gold bricks. The spent ore from the leaching vats was washed through holes in the bottom of the tanks to the dump. The tailings from the cyanide vats were discharged to Mason Canyon, Barnes-King Gulch, and Little Dog Creek and extended for miles down gradient from the mills in stream channels and flood plains (MHS 1974) (Figures 2-5, 2-6, and 2-9).

Historic Tailings – Mason Canyon

The Kendall Mill was located in Mason Canyon near the Kendall Pit and discharged tailings into Mason Canyon (Figure 2-6). The majority of the tailings were removed and used as heap leach pad underliner material during construction.

Historic Tailings - Barnes-King Gulch

The Barnes-King Mill was located at the head of Barnes-King Gulch. The mill used Barnes-King Gulch for tailings disposal. The drainage is ephemeral, dry most of the year. Tailings were transported primarily by mill water supplied from a pipeline constructed from Warm Spring located on the south side of the North Moccasin Mountains. A second pipeline may have also supplied water from Little Dog Spring located northwest of the mine. Historical air photos show tailings extending downstream in Barnes-King Gulch from the former mill site approximately 2 miles downstream (Figure 2-9).

Historic Tailings - Little Dog Creek

The North Moccasin Syndicate tailings are located in the North Fork of Little Dog Creek immediately east of the mine boundary (Figures 2-5 and 2-10). The Horseshoe waste rock dump was constructed directly on top of North Moccasin Syndicate tailings after some tailings were removed for heap pad underliner construction (CR Kendall 1992).

Comment [KJ1]: Life of Mine document

Off-site North Moccasin Syndicate mill tailings remain on the Shammel ranch property east of the mine. The majority of the tailings are located behind a series of three low earthen dams located east of the CR Kendall mine property boundary. The lowermost dam is clearly visible on air photos dating back to the late 1930s. A site inspection conducted in 2005 obtained measured dam widths at 240 feet for the upper dam, 275 feet for the middle dam, and 375 feet for the lower dam. All of the dams are oriented in a northeast to southwest direction. The lower dam is approximately 8 feet high, and vegetated with no signs of erosion. Surface water has been observed to pond behind the lower dam.

1.2.2 Modern Mining

Modern heap leach operations were initiated by Triad Resources in 1981 and continued by Greyhall Resources through 1986. Canyon Resources Corporation voluntarily took over the management of the site to prevent uncontrolled discharges of cyanide process solution during the bankruptcy of Greyhall Resources in 1987. Canyon Resources Corporation formed a joint venture with Addwest Gold Corporation called Kendall Venture and resumed mining in 1988. In 1990, Canyon Resources Corporation took over sole management of the property under the name of CR Kendall Corporation (CR Kendall). Mining ceased in February 1995. Gold recovery continued through the fall of 1997. The gold recovery process involved cyanide heap leaching, gold precipitation on zinc filings, carbon recovery, and smelting.

The operations disturbed 446 acres of land (CR Kendall 2004 Annual Report). According to the CR Kendall 2004 Annual Report 133 acres require reclamation. Of these 133 acres, the majority encompasses the ore processing areas in Mason Canyon (the Process Valley), including two heap-leach pads, the process plant, process water ponds, and several ancillary buildings and roads. CR Kendall reclaimed 314 acres of disturbance through 2004 (Table 1.1).

Comment [KJ2]: Add acres from 2004 reclamation.

Table 1.1 Reclamation at CR Kendall Mine as of December 2004

Type of Disturbance	Acres Reclaimed
Waste Rock Dump Tops (RPLs[1])	X
Waste Rock Dump Slopes	X
Pits	X
Heap Leach Pads (RPLs)	0
Other	X

[1]RPL means reduced permeability layer, a type of reclamation cover system: see Section XXX

Major site features include two heap-leach pads (LP#3 and LP#4), process water ponds (2B, 3B, 7, and 8), six pits (Horseshoe, South Horseshoe [backfilled], Muleshoe, Barnes-King, Haul Road [backfilled], and Kendall) and three waste rock repositories (Horseshoe, Muleshoe and Kendall). The modern mining features can be seen on Figure 1-2.

1.2.3 Reclamation Plan

In 1989, Operating Permit #00122 required the company to reclaim all accessible mine disturbances with 20 inches of soil salvaged from the disturbed areas of the mine site. As of March 1994, CR Kendall had only salvaged 11 inches of the required soils, which resulted in DEQ and the Bureau of Land Management (BLM) issuing a notice of non-compliance. As part of the settlement, which was reached in October 1995, CR Kendall prepared a revised reclamation plan (Schafer and Assoc. 1995) and a drainage and sediment control plan (Camp Dresser & McKee, Inc. (CDM)/Schafer and Assoc. 1995), which were reviewed and approved by DEQ.

The revised reclamation plan specified a reduced permeability layer (RPL) cover system on waste rock dump tops and the heap leach pads covering XX acres (Schafer and Assoc. 1995) (Cite new Figure 1-3, 3-1 from Ibid). The reclamation of other areas required 8 to 14 inches of soil. The RPL cover system is a 52- to 56-inch thick water barrier cover system.

Comment [KJ3]: Determine how many acres are in RPL from Exhibit 1 from Schafer and Assoc. 1995 revised reclamation plan.

RPL covers were used for all subsequent waste rock dump top reclamation. Analyses of the seepage issuing from the drain layer revealed that the materials used to construct the RPL covers may be a source of contaminants above WQB-7 standards, such as thallium (DEQ inspection report June 30, 1998). This would require collection and treatment of the water issuing from the drain layer.

Figure 1-2

Relocate Mason Canyon Spring--See Wayne

Legend needed:

Green areas=waste rock dumps Show RPLs as a different shade of green
Yellow areas=leach pads
Gray areas =other disturbances
Peach areas=pits
Yellow dots=collection areas

Light blue doesn't show up well

Red – historic tailings

Use symbol for different types of wells ?? WW-6 and WW-7 WW=water wells, PB=pumpback wells

Label pond 3 and mine water pond

Put current public access road in different color

Figure 1-3 [NEW]

Use figure 3-1 from Schafer and Assoc. 1995

In 1999, CR Kendall requested that the cover requirements in the closure plan be revised from a 52- to 56-inch RPL cover system to a 22-inch water balance cover system on the heap leach pads (CITE needed). A water balance cover system relies on soils to store infiltration water and uptake by plants to limit deep percolation into the waste rock. CR Kendall claimed infiltration modeling showed a 22-inch cover system would provide a similar level of infiltration as a 52- to 56-inch cover system. DEQ analyzed a 36-inch soil cover system to provide adequate growth medium for plants and a filter fabric to prevent loss of fine cover soils to the coarser underlying subsoil substitute (DEQ 2000 [EA]). DEQ, based on sampling of the sub-soil substitute, determined that the grain size distributions of this subsoil substitute and underlying spent ore were similar, eliminating the need for the filter fabric. On August 18, 2000, DEQ approved the 36-inch water balance cover system for the leach pads and 8 to 10 inches of soil for other areas of the site (DEQ 2000). CR Kendall appealed that decision to the Board of Environmental Review. That appeal is stayed indefinitely. The August 2000 approval is therefore not in effect.

In March 2001, CR Kendall submitted an Amended Closure Plan that included the previously analyzed 36-inch water balance cover (CR Kendall 2001a). DEQ reviewed the plan and prepared a draft environmental assessment (EA), which evaluated two cover alternatives (DEQ 2001a [CITE EA]). One alternative was the previously approved 36-inch water balance cover employing 17 inches of soil underlain by 19 inches of subsoil substitute. The other alternative was to use only the 17 inches of soil without the subsoil substitute layer. The EA showed that the physical and chemical properties of the subsoil substitute were similar to those of the spent ore and would add no benefit to the cover.

In the Final EA (DEQ 2001b), DEQ concluded that potentially significant cumulative effects on area resources from activities in the area were projected, and a complete reevaluation of potential reclamation materials was warranted. In addition, DEQ concluded that a water treatment plan for the entire site was needed to identify the potential impacts of activities such as the land application of process solutions, which are saline and contain metals.

DEQ stated that an environmental impact statement (EIS) was needed to address the soil, vegetation, and water resources effects from this salt and metal load and its effects on CR Kendall's proposed amended water resources management plan (CR Kendall, 2001b). These salts and metals might have a detrimental effect on establishing and maintaining a viable vegetative cover.

In 2004 a minor revision to regrade the heap leach pads and the process valley area between the pads was submitted and approved. The heap leach pads have been regraded with 3:1 slopes and a storm water diversion was constructed. Some areas around the process valley were soiled and seeded and the east wall of the Barnes-King Pit was regraded.

1.3 Public Involvement Process

Public involvement is a key element in preparing an EIS. The first opportunity for public involvement occurred in the beginning of the EIS process when "scoping" was conducted. Scoping is a process designed to identify a broad list of environmental issues related to the

Proposed Action. Given the high level of public interest in this project, CDM[1] and DEQ used a consensus-building process known as the Stakeholder Involvement Process (SIP) to assist in identifying issues and developing a range of alternatives for the EIS. The SIP is a valuable tool in integrating divergent operational, financial, environmental, and socioeconomic interests of stakeholders during the EIS process. The SIP included the following activities:

- Public Interviews.
- Scoping Document.
- Open House.
- Public Meeting.
- Technical Meetings.

Issues were identified based on stakeholder input during the SIP. Additional details on the SIP are presented in Chapter 6.

With the release of the draft EIS, the public has a second opportunity for involvement. During the public comment period, the public has the right to submit comments on the adequacy or inadequacy of the draft EIS and the analyses. Written comments as well as verbal comments taken at a hearing will be collected. DEQ will review comments and sort out all substantive comments and provide responses to those comments. Some responses may require changes in the EIS; others will not.

No comment period is provided for a final EIS or the DEQ's record of decision (ROD). The public may file suit against the State according to the Administrative Procedures Act in the first judicial district or in the district court in which the mine is located.

1.4 Issues and Development of Alternatives Process

Based on the results of the SIP, the following key issues have been identified. The italicized text indicates how DEQ will evaluate and estimate effects relative to those issues.

Issue 1: Effects on quantity and quality of surface and ground water resources.

- Discharges from the mine to both surface and ground waters may exceed water quality standards for certain contaminants including arsenic, antimony, selenium, thallium, cyanide, and nitrate. *Effects are predicted by evaluating existing water quality data and analyzing the effectiveness of various reclamation cover systems, including existing cover systems.*
- The land application of process water and mine drainage may affect the quality of surface and ground water. *Effects are predicted by calculating the amount of contaminants moving through the cover systems and underlying materials that could reach surface or ground waters.*

[1] CDM was contracted by the Montana Department of Environmental Quality (DEQ) in January 2003 to begin an Environmental Impact Statement (EIS) for the proposed reclamation at the CR Kendall Mine.

- Pumpback of contaminated ground water and capture of surface water have reduced downgradient water quantity in four watersheds. Water management at the mine may continue to reduce downgradient water quantity. *Effects are predicted by estimating captured versus returned surface water flows from various water management alternatives.*

- Pumping of clean groundwater from water wells WW-6 and WW-7 may have reduced water quantity in downgradient wells. *Effects are predicted by estimating the amount of water pumped versus estimated aquifer drawdown from pumping.*

- The water quantity problems attributed to the mine may be the result of the drought. *Effects are predicted by estimating annual variations in local precipitation in each watershed versus the amount pumped back by the mine.*

- The mine facilities have intercepted natural drainages that channeled stormwater and snowmelt that no longer reach drainages below the mine. *Effects are predicted by estimating the amount of rainfall and snowfall on the areas captured by the internally draining portions of the mine pits and the heap leach pads versus how much runoff would have reported to the drainages before these facilities were constructed.*

- Water quantity in each drainage should be augmented by rerouting drainage channels and developing springs and other groundwater sources. *Effects are predicted by determining if water quantities have been impacted in each drainage and evaluating methods to augment flows in each drainage if needed.*

- Water and sediment from the mine may contribute arsenic to the Boy Scout pond downgradient of the permit boundary in South Fork Last Chance Creek. *Effects are predicted by analyzing water quality trends of the pond since reclamation of the Kendall waste rock dump.*

- The underdrain in the process valley could be receiving impacted water. *Water that has contacted waste rock and historic tailings reports to the underdrain. Effects are predicted by reviewing water quality data. The alternatives will address treatment options.*

Issue 2: Effects on soils and reclamation.

- Reclamation efforts to date may have resulted in inadequate vegetation in some areas, erosion on steeper slopes, and excessive infiltration through the cover systems. *Effects are predicted by evaluating vegetation success, erosion, soil thickness, and volumes of water intercepted by the pumpback systems.*

- Application of reverse osmosis (RO) brine on the leach pads may have resulted in elevated levels of salts and other potential contaminants possibly affecting the reclamation cover system and future revegetation. *Effects are predicted by estimating the effects on soils and vegetation from upward migration of salts and other potential contaminants into the cover system. [COLLECT SOME SAMPLES FROM REGRADED HEAP LEACH CAP]*

- Application of process water and RO brine on reclaimed areas may have resulted in elevated levels of salts and other contaminants possibly affecting the reclamation cover system and existing vegetation. *Effects are predicted by estimating the effects on soils and vegetation from salts and other potential contaminants in the cover system.*

- Insufficient and unsuitable on-site reclamation materials may limit reclamation cover system alternatives. Off-site borrow materials should be identified and considered. *Effects are predicted by estimating soil parameters to identify suitable soil substitutes, evaluating alternative reclamation covers requiring less reclamation material, and evaluating the possibility of importing material from off-site borrow areas.*

Issue 3: Effects from backfilling pits.

- Pits could be restored to a free-draining condition. *Effects are predicted by comparing area of pits and amount of potential runoff from precipitation and snowmelt captured by the pits and lost to downstream users.*

- The heap leach pads and/or waste rock dumps should be removed during reclamation activities. *Effects would be estimated by assessing water quality benefits from moving these facilities and available space in pits to contain the removed material.*

- A storage area could be provided for potentially contaminated materials removed from drainage ways (i.e. waste rock dumps, historic tailings, etc.). *Effects are predicted by evaluating the amount of seepage through the potentially contaminated materials reporting to the Madison Limestone aquifer.*

- Aesthetics of the project area could be improved. *Effects are predicted by comparing post-mine topography with pre-mine and current topography, and the visibility of remaining highwalls from key observation points.*

1.4.1 Issues Considered But Eliminated from Further Analysis

DEQ reviewed the SIP and identified some issues raised by the public that were outside the scope of this EIS, items that are addressed by law or regulation, items that are unrealistic or unreasonable to implement, and insignificant issues that are covered by larger and significant issues. Rationale for eliminating these issues is provided in the descriptions below.

- The adequacy of the existing reclamation bond and the updated reclamation bond for the selected alternative should be addressed. *Estimates of reclamation bond amounts will be included in the EIS for each alternative. Final bond amounts will be determined by DEQ after completion of the EIS and selection of a reclamation and water management plan and the adequacy of the bond will not be considered as a separate issue in the EIS. This issue is addressed by law and regulation.*

- The cost of the selected alternative may exceed the reclamation bond. If CR Kendall cannot fund the entire cost of the reclamation and long-term water treatment, then the public would have to pay. *Alternatives are developed to address environmental concerns but the cost of* *an alternative is not a driving issue. Cost may be used to choose between otherwise similar alternatives or mitigations. Any alternative selected must be reasonable and meet minimum requirements under Montana state statutes. CR Kendall's ability to pay for the reclamation is outside the scope of the EIS. [JOHN IS THIS CORRECT?]*

- Since DEQ previously approved a reclamation plan, an EIS is not necessary. *DEQ concluded in its 2001 EA on CR Kendall's Amended Closure Plan (CR Kendall 2001a) that there were potential significant impacts. Under MEPA, this requires the preparation of an EIS. DEQ also determined that the EIS should cover water treatment. CR Kendall has appealed DEQ's decision to the Board of Environmental Review. [JOHN IS THIS CORRECT?] This issue will not be carried forward and is addressed by law and regulation.*

- DEQ will develop the EIS with a predetermined preferred alternative for reclamation and water treatment. *DEQ hired a third-party contractor to develop a range of alternatives for consideration by the decisionmaker, the director of DEQ. The EIS will provide the basis for the decisionmaker to select between alternatives. MEPA requires the development of reasonable alternatives that meet legal requirements. This issue will not be carried forward and is addressed by law and regulation.*

- DEQ and CR Kendall have shown a lack of interest in involving the public on mine-related issues. *DEQ hired a third-party contractor that conducted an expanded public involvement process during the scoping process (CDM 2004 Scoping Report). This process is described below under Section 1.3 and goes beyond the legal requirement under MEPA. This issue will not be carried forward and is addressed by law and regulation.*

- DEQ should ensure the reclamation is effectively implemented and meets legal requirements. *DEQ would monitor implementation of the selected alternative and pursue enforcement actions if reclamation does not achieve legal requirements. This issue will not be carried forward and is addressed by policy, regulation, and statute.*

- The overall effect of the Kendall Mine on the local economy should be evaluated. *The EIS addresses the economic impacts of reclamation and water treatment for each alternative in a cost-benefit analysis. Mitigating the economic impacts of mine operation and judging if the impacts are positive or negative are beyond the scope of this EIS.*

- BLM should be a co-lead agency in preparing the EIS. *In 1995 BLM and CR Kendall completed a land exchange. As a result all lands within the permit boundary are privately owned. BLM has no land management responsibilities. BLM's permitting involvement in the past is outside the scope of this EIS. DEQ has no authority to require BLM to participate, but BLM will be given an opportunity to comment on the draft EIS. This issue is outside the scope of this EIS and is addressed by law and regulation.*

- Hazardous wastes should receive special treatment. *Waste rock, spent ore, and historic tailings do not qualify as hazardous waste under the Code of Federal Regulations (CFR)(40 CFR 261.4(17), etc) because they are exempt (Bevel Exclusion ??). Spent zeolite from water treatment columns are buried in the heap leach pads and are not considered as hazardous waste based on toxicity characteristic leaching procedure (TCLP) analyses (CITATION get from Glen Pegg or data* *gap). Reverse osmosis brine was recirculated to the heap leach pad, mixed with process water, and eventually land applied. All mining wastes either pass TCLP or are Bevel excluded. Water and seepage from all facilities are intercepted and captured by the pumpback system and either land applied or treated in zeolite columns to ground water discharge standards and discharged in the Kendall Pit. Hazardous materials from the assay lab were disposed off-site (get from Glen Pegg). This issue is addressed by law and regulation.*

- The slopes of the heap leach pad should be terraced to catch surface water until vegetation can use it. *The goal of the reclamation cover design is to minimize infiltration and maximize runoff in a controlled fashion. The use of terraces would increase infiltration. The goal of this issue is unreasonable on this site, but the use of benches on the heap leach pad is addressed under the stormwater section.*

- The buffering capacity of the waste rock should be enough to prevent acid mine drainage (AMD). *Waste rock dumps and the heap leach pads contain materials dominated by limestone. The pH of all seepage from waste rock dumps and the heap leach pad is above 7. DEQ does not expect the buffering capacity to be depleted over time. The long-term problem at the Kendall Mine is not acid mine drainage, but near neutral metal mobility, especially metalloids including thallium, arsenic, and selenium, which are most soluble in non-acidic conditions. Near neutral mobilization of metalloids is addressed in the water quality section. The only natural acidic seep in the area is associated with a coal seam located outside the disturbed areas of the mine. The issue of AMD is not relevant to this site.*

- Disposal of mine wastes into pits could result in contaminated seepage into the Madison limestone, which could affect the Lewistown water supply and Petroleum County. *The regional flow in the Madison limestone aquifer in northeastern Montana is generally to the north (Feltis 1983). The Snowy Mountains, southeast of Lewistown, provide the source of water for the spring used for the Lewistown water supply. Petroleum County is further southeast. DEQ has concluded that any backfill placed in the pit would not affect the Madison aquifer and water supplies south and east of the mine. This concern will not be carried forward as a separate issue. Potential impacts from partial pit backfill will be discussed under the water quality section.*

- The pit floors should be lined with impermeable materials before backfilling. *This action would trap water within the backfilled material and would increase the contact between water and waste material. This could result in a need for pumping and treating the trapped water even if a liner was also placed over the backfill. There is no additional benefit to placing a liner beneath pit backfill in addition to a liner in the reclamation cover system. This concern will not be carried forward as a separate issue. DEQ will be evaluating various reclamation cover systems to minimize the amount of infiltration through any pit backfill.*

- Highwall stability should be evaluated. *The pit highwalls have been in place for at least 10 years with minimal raveling and sloughing. The majority of the highwalls were developed into Madison limestone, which naturally forms cliffs. Pit backfill will be evaluated as a means of increasing surface water runoff from free-draining pits and in cases where waste rock relocation would eliminate the need for long-term capture and water treatment. Pit highwall stability will not be carried forward as a separate issue.*

- Ditches should be constructed on native grounds rather than on disturbed materials. *This concern will not be carried forward as a separate issue. Drainage channel design and location will be discussed under the stormwater section for each alternative. Where possible DEQ will consider placing drainage channels on native ground.*

- Surface water quality monitoring may not adequately identify all exceedences. *Through the EIS, the adequacy of the monitoring program will be reviewed. If additional monitoring is needed it would be addressed under Issue 1 and under Water Quality in Chapter 4. This concern will not be carried forward as a separate issue.*

- Piping water from Little Dog Creek around the mine instead of letting it go underground may unfairly allocate water to a specific landowner. *Addressing the fairness of where this water goes is outside the scope of this EIS. The pumpback system removes water from lower Little Dog Creek drainage. CR Kendall proposed this means of augmentation as a way to replace water to the drainage. The impacts of augmentation to each drainage are addressed under water quantity for each alternative.*

- DEQ shows favoritism to CR Kendall and/or specific landowners. *DEQ is a neutral regulator and must work with CR Kendall and landowners to address reclamation and water treatment at the mine. Alternatives in this EIS address the key issues and are not developed to meet the needs of CR Kendall or the landowners. [JOHN PLEASE LOOK AT THIS.] This issue is outside the scope of the EIS.*

- The compensation to local ranchers by CR Kendall for alleged water losses may be an admission of guilt. *Water quantity issues are covered under Issue 1 and water quality and quantity in Chapter 4. This issue is outside the scope of this EIS.*

- Existing water rights may be compromised by mining or reclamation activities. *Effects on water quantity are predicted by estimating changes in water availability as a result of mining and reclamation and water treatment activities. Impacts to individual water rights are beyond the scope of the EIS. DNRC will use the information in this EIS to evaluate impacts to water rights.*

- Several resources, which will not be affected by any of the alternatives, are not anticipated to be affected by the Proposed Action. Further discussion of these topics is included in Chapters 3 and 4. Below is a summary of why these resources are not considered issues:

    - Cultural resources: No cultural resource issues have been raised during the life of the mine. *Alternatives being considered would disturb minimal new acreage. A cultural resources evaluation report was completed for the permit area in 1989 (GCM Services Inc. 1989). If any new disturbances would occur outside the area covered by the report, the area(s) would be investigated for cultural resources. This mitigation has been added to each alternative.*

    - Fisheries and aquatics: Fisheries and aquatics were not raised as issues during scoping. *The only fisheries issue identified during mine life concerned a fish kill at the Boy Scout Pond in South Fork Last Chance Creek in July 1995? (CITATION). DEQ investigated potential sources of sediment and metal contamination to the pond. DEQ could not determine* *whether the arsenic levels in sediment were related to current or historic mining operations or natural background levels (DEQ inspection report April 13 and 14 1998, any water protection bureau inspection reports? Ken Kapsi). [CHECK] FWP concluded that the fish kill was due to oxygen depletion due to stirring up of the pond by the storm surge (CITE FWP memo). During analysis of effects to water quality and quantity, any potential effects to fisheries and aquatics would be disclosed in that analysis.*

- Threatened and endangered species: No threatened and endangered species have been observed during the baseline surveys or the life of the mine. *CR Kendall attempted to introduce peregrine falcons in the mid 1990's, but the falcons have since left the site. No impact to threatened or endangered species habitat would result from implementation of alternatives in this EIS.*

- Air quality: No air quality issues have been raised during mine operation or during the scoping process. *Dust control would continue as conducted throughout the life of the mine. Reclamation of the remaining acreage would further reduce potential sources of dust. Equipment emissions would be similar to operational levels during reclamation activities, but would cease when reclamation was completed.*

- Socioeconomics: Socioeconomics was not raised as an issue during scoping. *Socioeconomic impacts were evaluated in 1989 (CITE 1989 EA). Any new socioeconomic impacts from implementing one of these alternatives will be discussed under other resource areas as appropriate (land use, water treatment, etc.).*

■ Water reservoir should be retained for fire fighting purposes. *Retaining an existing pond or constructing a new reservoir for fire fighting purposes was raised during the scoping process. This water storage facility will be considered under the water management plan for each alternative, but not carried forward as a separate issue.*

■ Noxious weeds from the mine may have spread to exploration roads and neighboring properties. *Noxious weed control has been conducted during mine life, but Canada thistle and houndstongue continue to expand on the site. These weeds are common throughout the region and it would be difficult to determine the seed source. Seeds are spread by wind or carried by animals. Noxious weed control will be addressed as part of the revegetation plan for each alternative but will not be carried forward as a separate issue.*

■ Historic tailings in the streambeds below the permit area should be removed to prevent recontamination of treated water discharge. *DEQ cannot legally require CR Kendall to remove the historic tailings outside the permit area. DEQ is considering removal of the tailings in the alternatives to use as the cushion layer under the flexible membrane liner of reclamation cover systems. If CR Kendall does not elect to remove the tailings if a DEQ alternative is selected, DEQ would not allow CR Kendall to discharge treated water directly into drainages with contaminated streambeds, but would allow the water to be gravity piped to stock ponds or to the stream below the tailings. The use of the tailings for a reclamation cover material is discussed under water quality.*

■ Reclamation should protect people and property from long-term effects from the mine. Reclamation should meet laws and regulations relative to non-degradation, property rights, trespass, etc. *Reclamation of the mine site must comply with all requirements of the Metal Mine Reclamation Act as well as complying with the Montana Water Quality Act and the Montana Environmental Policy Act. This issue is addressed by existing laws and regulations.*

- Sediment from the mine site has contaminated the Boy Scout Pond. *Water sampling in the past has shown arsenic levels above water quality standards (WQB-7 2004). Based on current data, arsenic is below water quality standards. Skin exposure to arsenic is regarded as safe at much higher concentrations than for drinking water. CR Kendall is required to monitor the pond under its permit and will be required to continue monitoring until DEQ determines it is no longer necessary. This issue is addressed by existing laws and regulations.*

1.5 Purpose and Benefit [KATHY CHECK MEPA NEED VS BENEFIT]

The purpose of the Proposed Action is to provide a reclamation and water management plan for the CR Kendall Mine site that meets Montana state law.

1.5.1 Summary of the Proposed Action [MAKE CONSISTENT W/TABLE 2—KATHY TO DO]

The Proposed Action will consist of the following elements:

- Leach Pad Reclamation:
- Placing a 40-mil synthetic single membrane and 20-inch soil cover over the leach pads.
- Partially backfilling some pits.
- Regrading the north face of the Kendall Dump and the Kendall Pit backfill to 2.5:1 (horizontal:vertical) slopes.
- Placing an additional layer of soil onto some waste rock reclamation covers depending on vegetation success.
- Placing 8-14 inches of soil in disturbed areas that are not over waste.
- Based on MPDES effluent limits water treatment may be required within each drainage using passive adsorption-based systems. LAD will be retained as a contingency.
- Removing of existing step pools (following establishment of vegetation) and amending selected ditches with graded filter materials to minimize infiltration into wastes.
- Removing the accessible off site tailings and placing them onto the leach pads (prior to capping) or in pits.
- Retaining site infrastructure, such as process buildings and lined ponds, needed for long-term site management, especially water treatment.

- Installation of a drainage system to gravity drain water from the collection cisterns (pump-back systems).
- Revegetate the waste rock and leach pad reclamation covers and the disturbed areas.
- Water augmentation using treated groundwater (from the collection cisterns) and upgradient springs (pending BLM approval for Mason Canyon spring).

1.5.2 Objectives of the Proposed Action

The objectives of the Proposed Action are divided into primary goals, which consist of improving reclamation success, limiting the amount of water needing treatment, protecting water quality, restoring water quantity, and ensuring public safety. Secondary goals include improved aesthetics and future land use.

1.5.2.1 Primary Goals and Benefits

The primary goals and benefit of the alternative at the CR Kendall site include the following:

1.5.2.1.1 Improve Reclamation Success

- *Improve revegetation of the mine site.* Revegetation would be improved by reducing slopes, adequately characterizing reclamation materials, adding soil amendments as needed, modifying reclamation cover systems, limiting the use of LAD with water containing thallium and salts from the heap leach pads and controlling noxious weeds. Only treated water with low thallium levels could be used to help establish vegetation. These measures would result in reduced thallium in vegetation, increased production and cover of revegetation species for wildlife and livestock, improved erosion control, and reduced seepage through mine wastes. LAD would only be used as a contingency when other treatment systems are down.

1.5.2.1.2 Limit the Amount of Water Needing Treatment

- *Limit Contact between Mine Wastes and High Quality Surface Water and Groundwater.* Separating high quality surface water and groundwater from modern as well as historic mine wastes is a form of source control. Generation of poor quality water would be limited. Source control, where practicable, is often more efficient than treatment. This measure would reduce long-term water treatment costs. In some instances, historical mine tailings may be inaccessible and it may not be possible or practicable to prevent contact.
- *Limit low quality mine waste seepage into groundwater.* Limiting low quality seepage from mine waste into groundwater is a form of source control that should help to limit groundwater contamination. Currently, migration of groundwater contamination is limited by use of the pump-back system. By providing source control, the amount of water and/or contaminant loading to be treated would be decreased. This measure would reduce long-term water treatment costs.

1.5.1.2.3 Protect Water Quality

- *Limit Transport of Fine-grained Mine Wastes and Contaminated Sediments.* Improving revegetation success, limiting erosion, and improving stormwater management would limit or minimize the transport of fine-grained wastes or contaminated sediments off site. This measure would protect down-gradient water quality.

- *Meet Montana Surface Water and Groundwater Quality Standards for Mine Waters Leaving the Site.* Mine waters must meet Montana water quality standards or MPDES permit effluent limits for thallium, arsenic, selenium, and other parameters before leaving the site (WQB-7 Jan 2004). Minimizing the amount of water needing treatment and improving revegetation success would increase the potential for meeting standards. Treatment systems would be developed and implemented to achieve this goal. By meeting water quality standards or MPDES permit effluent limits, mine water can be discharged off site and down-gradient water quality would be improved and water quantity would be increased.

1.5.1.2.4 Restore Water Quantity

- *Restore Water Quantity in Each Drainage to Pre-modern Mining Levels.* The quantity of water would be either maintained at existing levels or returned to pre-modern mining levels, if possible or practicable. Increased runoff could be achieved by limiting infiltration into mine waste, improving stormwater drainages, partially backfilling pits, replacing pump-back systems with passive free-draining water treatment systems, and augmentation from one or more up-gradient springs. CR Kendall is currently providing replacement water to Little Dog Creek from two water supply wells and from Little Dog Creek Spring. South Fork Last Chance Creek receives replacement water from the two water supply wells. CR Kendall would continue to provide replacement water as long as the pumpback system is required. These measures would increase water quantity for down stream beneficial uses.

1.5.1.2.5 Ensure Public Safety and Access

- *Limit Public Access to Sensitive or Potentially Dangerous Areas of the Site.* Areas of the site that are potentially dangerous (i.e., highwalls) and areas that require protection from public access (i.e., newly revegetated areas) would be designated and appropriate measures taken to prevent public use and access of the CR Kendall Mine property while allowing pubic access through the private property to BLM lands west of the mine. These measures would reduce public hazards and improve revegetation success.

1.5.2.2 Secondary Goals and Benefits

Secondary goals and benefits of the Proposed Action include improved aesthetics and removal of off-site tailings. The secondary goals would be met if possible, but where conflicts exist between primary and secondary goals, priority will be given to the primary goals.

- *Improve the Aesthetics of the Site.* Improving aesthetics would be accomplished by improving revegetation success, regrading slopes to blend with adjacent natural topography, partially backfilling some pits, and reducing the visibility of remaining highwalls from key observation points. Improved site aesthetics would make the area less visible.

- *Remove Off-site Historic Tailings.* Off-site tailings are not the responsibility of CR Kendall, but they impact water quality, riparian habitat, and aesthetics in Barnes-King Gulch and Little Dog Creek. Off-site tailings could be used for synthetic liner cushion material under reclamation covers or for partial backfill in some pits. This measure would prevent the recontamination of water leaving the mine site in those drainages, improve riparian habitat and aesthetics, and enhance downstream beneficial uses.

Chapter 2
Description of the Proposed Action and Alternatives

2.1 Screening Criteria

The proposed alternatives that were derived from the SIP were compiled and evaluated based on the screening criteria presented below. The alternatives considered for each drainage are shown in Table 2-1.

The main screening criteria used to eliminate components of the alternatives from further analysis were based, in part, on how well the components met the objectives outlined in Chapter 1. The following criteria for each proposed reclamation component were considered:

- Effectiveness (how well the alternative component met the objectives).
- Adverse Impacts (alternative components that have few or no adverse impacts to resources would be favored over alternative components with many adverse impacts).
- Implementability (can the alternative component be performed using existing technology?).
- Consequences of failure (if the component should fail to perform as planned, how would this affect the resources?).
- Reliability (how likely is the alternative component to fail?).
- Reasonableness [CHECK MEPA]
- Cost (used only as a tie breaker in the event that two alternatives are equal with respect to all other criteria).

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Table 2-1

2.2 Description of Alternatives

2.2.1 No Action Alternative

In 1989, CR Kendall was issued Operating Permit #00122 that required the company to reclaim all accessible mine disturbances with at least 20 inches of replacement soil salvaged from the disturbed areas of the mine site. As of March 1994, CR Kendall had salvaged only 11 inches of soil; DEQ and the Bureau of Land Management (BLM) issued a notice of non-compliance. As part of the abatement CR Kendall was required to submit a revised reclamation plan for agency review and approval. As part of October 1995 settlement, the agencies approved CR Kendall's Soils and Revegetation Plan for Final Closure at the Kendall Mine (Schafer and Assoc. 1995) (hereafter referred to as the 1995 Soils and Revegetation Plan) and the Drainage and Sediment Control Plan (CDM/Schafer and Assoc. 1995).

The 1989 Plan of Operations did not envision the need for any water treatment other than cyanide neutralization and land application disposal of neutralized process solutions. Baseline water quality and geochemical analyses did not include testing for thallium because Montana did not have standards for thallium at that time. CR Kendall began monitoring for thallium in 1994. Thallium levels exceeded standards in waste rock dump seepage and groundwater in the leach pad underdrain resulting in the construction of the pumpback systems in 1996 (CR Kendall May 1996). Operational water treatment using zeolite columns and reverse osmosis was permitted in August 1997 and treated water was discharged into the Kendall and Muleshoe pits (CR Kendall August 12, 1997, DEQ MR 97-003).

For the purposes of this EIS, the 1989 Plan of Operations, 1995 Soils and Revegetation Plan, and the pumpback and water treatment plans are considered to be the No Action Alternative. Specific items addressed in the plan include regrading and final post-mine topography; soil and reclamation materials volumes, placement, and specifications for all disturbances; design and construction of a reduced permeability layer (RPL) system to decrease infiltration into and seepage out of waste rock dumps and heap leach pads; and a final revegetation plan including seed mixes, planting densities, and vegetation community establishment. Additionally, this plan described changes in the amounts and types of reclamation materials compared to the plan approved in 1989. An aerial photograph of the site showing the main features of the No Action Alternative is provided as Figure 2-14.

2.2.1.1 Leach Pad Reclamation

Leach Pad Design and Operation

The Kendall Heap Leach pads (Leach Pad 3 and Leach Pad 4) consist of approximately 4.1 million cubic yards of spent ore covering an area of about 56 acres (Figure 1-2). Ore was mined at the site from several pits, including the Kendall, Haul Road, Barnes-King, Muleshoe, South Horseshoe, and Horseshoe pits. After excavation, crushing, and agglomerating[2], the ore was stacked onto the heap and sprinkled with a 200-300 ppm cyanide solution (called the barren solution), which dissolved the gold and other precious metals contained in the ore. The

[2] Agglomeration is a process by which particles of smaller materials are brought together to form larger particles through adhesion

extraction process is referred to as heap leaching. After the cyanide dissolves the gold from the ore the resultant liquid solution is called the pregnant solution. During active mining, the pregnant solution would percolate through the lower part of the heap leach pad until reaching the pad liner, where the solution was collected and conveyed to the process plant for gold extraction.

Since the closure of the mine, cyanide solution is no longer added to the heap leach pads. Cyanide is at far lower concentrations, 1 ppm, than during active mining. The concentrations of cyanide, nitrate, and metals such as thallium are still at levels that are too high to be discharged to surface water or groundwater.

Regrading.
The heap leach pad would be regraded to 3:1 slopes with 10-foot benches every 100 feet (1989 POO). A 1994 modification to the 1989 regrading plan included filling the low area between the heap leach pad and the process plant with waste rock to facilitate drainage (CR Kendall Construction Report October 1994). This was required because not as much ore was mined as anticipated, resulting in an enclosed basin upgradient of the heap leach pad rather than a free-draining surface. Waste rock was placed in this basin to establish the approved post-mining topography. The conceptual grading plan was revised in Schafer and Assoc. 1995 (Exhibits 1 and 2 in Schafer and Assoc. 1995). The inside portions of most benches would be lined with clay and tied into a drainage system to reduce the amount of infiltration into the heap leach pad (CDM/Schafer and Assoc. 1995??). Regrading was completed by CR Kendall per the approved plan in 2004 (Schafer and Assoc. 1995 and Minor Revision 04-001).

Comment [KJ4]: Add cite to references cited

Reclamation Cover Design.
After cyanide neutralization and regrading, the heap leach pads were to be covered with 20 inches of soil according to the 1989 POO. This was revised in 1995. The 1995 Soils and Revegetation Plan specified a 52- to 56-inch thick water barrier cover system (Figure 2-X) using, from top to bottom:

- 10 to 14 inches of stockpiled soil,
- 18 inches of pit-run waste rock with subsoil-like qualities, hereinafter called "subsoil substitute",
- 12 inches of pit-run Madison limestone used as a coarse drain layer, and
- 12 inches of compacted pit-run Kibbey shale used as a clay layer to reduce permeability.

The RPL's were designed to route precipitation infiltrating through the soil layers to the drain layer and into the stormwater drainage channels. The flatter tops of the leach pads with less than 10 percent slopes would receive the best quality, type A, soils with the highest organic matter content and lowest coarse fragment content for the upper layer. Moderate slopes, between 10 and 33 percent, would receive medium quality, type B, soil, which contain lower organic matter content and more coarse fragments. Steeper slopes, from 33 to 50 percent, would be reclaimed with the coarsest soil available (type C) to decrease erosion and facilitate establishment of trees (Schafer and Assoc. 1995). None of the heap leach pad slopes exceed 3:1 or 33 percent.

The quantities of soil and subsoil substitute required for the remaining reclamation to be done under the No Action Alternative are presented in Table 2-9. To complete the RPL cover system, leach pad 3 would also need 25,813 CY of drain rock and 25,813 CY of pit-run shale, and leach pad 4 would also need 64,533 CY of drain rock and 64,533 CY of pit-run shale.

Table 2-9
No Action Alternative Soil and Subsoil Substitute Requirements for Remaining Reclamation

Type	Area (acres)[1]	Soil & Subsoil Substitute Thickness (average inches)	Soil Requirement (CY)
Leach Pad 3	16	30	64,533
Leach Pad 4	40	30	161,333
Kendall Dump	~~53~~ few	0	0
Muleshoe Dump	0	0	0
Horseshoe Dump	0	0	0
Other disturbed areas (including portions of pits to be soiled)	40	8-14	64,533
Total	**~~253~~ 138**		**290,399**

[1]Acres based on 2004 annual report

Comment [KJ5]: base soil depths and acreage for other disturbed areas on 1995 Soils and Revegetation map and recalculate volumes

Pad Liner System.
The construction of the liner system below the heap leach pads is similar to the construction used at landfills and waste repositories that store hazardous substances. The heap leach pads were constructed by depositing ore on a composite liner system underlain by a leak detection system and blanket drain layer. A liner was installed between heap leach pads 3 and 4 in 2004 to allow effluent from heap leach pad 3 to gravity flow to heap leach pad 4 (Womack & Associates, Inc. 2005).

Comment [KJ6]: Construction Observations Report for Pad Liner Extension Between Leach Pads 3 and 4, April 11, 2005. Prepared for CR Kendall. Add to references cited.

Heap leach pad 4 was constructed with the following layers from top to bottom (new Figure 2-?? From 1989 POO-Fig 6). Heap leach pad 3 was less complex and consisted of the upper four layers over compacted native materials.

- Ore layer up to 220 feet thick;
- 18 inch cushion layer or overliner of historic tailings
- 40 mil flexible membrane liner (FML) made of polyvinylchloride (PVC) having a very low permeability (Figure 2-2) (30 mil on heap leach pad 3);
- 8-12 inch compacted underliner comprised of bentonite clay amended tailings;
- geotextile
- 300 foot wide, 12-inch thick main underliner of gravel drain with 2 to 4 inch perforated pipe to function as a leak detection system;
- 4 inch clay layer
- compacted fill layer of variable thickness
- geotextile

- 12 to 18 inches angular rock drain blanket with 2 to 8 inch perforated pipe overlying bedrock or other native materials under the entire heap leach pad

The bentonite clay-amended tailings in the compacted underliner has low permeability and small particle size. The small soil particle size with no large cobbles or boulders in the overliner and underliner helped keep the ore from puncturing the FML. The liner and the compacted underliner were intended to keep the pregnant solution from leaking into groundwater. The liner and associated collection system protects the groundwater by directing the leachate to process Ponds 7 and 8 (Figure 1-2). The main underliner and associated clay layer located along the axis of Mason Canyon drainage function as a leak-detection system and route water to a lined catch pond and then to Pond 7 or to pumpback system TMW-26. An angular rock blanket drain that is overlain by compacted fill underlies the entire heap leach pad. This drain layer collects groundwater and routes it under Ponds 7 and 8 to pumpback system TMW-26. The groundwater can be intercepted and collected at a sump between the dike and Pond 7 and then routed into Pond 7 if the water is contaminated.

At closure, when heap leach pad effluent met cyanide discharge criteria, the underliner would be perforated by drilling through the liner and underlying layers into the angular rock drain (1989 POO). Any heap leach pad effluent would report to the angular rock drain, mix with groundwater, and discharge to Mason Canyon.

2.2.1.2 Pit Backfill and Reclamation

No backfilling was proposed for any pits in the 1989 POO, but partial pit backfilling would be done if feasible (POO, pages 2-91 and 3-18). In late 1992, after CR Kendall determined that there were fewer ore reserves than anticipated, they elected to partially backfill some pits as described below (CR Kendall 1992) and as shown in Exhibit 1 of Schafer and Assoc. 1995.

Comment [KJ7]: CITATION- Life-of-Mine Plan and Disturbance Summary, December 1992, received 12/18/1992

Kendall Pit.
In 1994 and 1995, CR Kendall stockpiled selected waste rock potentially suitable for RPL construction in the Kendall Pit. The accessible benches were soiled and revegetated in 1995. Stockpiles of RPL materials would be removed as needed and the remaining materials would be regraded in place, soiled and seeded (Schafer and Assoc. 1995). Based on the Schafer plan XX acres of the Kendall pit would be reclaimed as rock faces and XX acres would be soiled, seeded and revegetated.

Haul Road Pit.
The Haul Road Pit was mined, completely backfilled and then soiled, seeded, and revegetated in 1994 (CR Kendall 1994).

Comment [KJ8]: CR Kendall Construction Report October 21, 1994

Barnes-King Pit.
CR Kendall completed partial pit highwall reduction on the east highwall in 2004 (Minor revision 04-00X). This part of the pit is not soiled and seeded to date. Based on the Schafer plan as modified by the regrading in 2004, XX acres of the Barnes-King Pit would be reclaimed as rock faces and XX acres would be soiled with 8 inches of type C soils, seeded and revegetated. [CHECK TO SEE IF RECLAMATION WAS DONE ON ACCESSABLE BENCHES IN 1995. CHECK WITH GLEN ABOUT SLOPE ANGLES]

Muleshoe Pit.
The Muleshoe Pit was partially backfilled with waste rock, regraded to 2:1 slopes or less, soiled, and seeded in 1994 and 1995 (CR Kendall 1992). Based on the Schafer plan XX acres of the

Comment [KJ9]: add cite to references cited Life-of-Mine Plan and Disturbance Summary

Muleshoe Pit would be reclaimed as rock faces and XX acres would be soiled, seeded and revegetated.

South Horseshoe Pit.
The South Horseshoe Pit was completely backfilled, soiled and seeded in 1993 (CR Kendall 1992).

Horseshoe Pit.
The Horseshoe Pit was partially backfilled, soiled and seeded in 1993 through 1995 (CR Kendall 1992). Based on the Schafer plan XX acres of the Kendall pit would be reclaimed as rock faces and XX acres would be soiled, seeded and revegetated.

Cover Soil for All Pits.

The 1989 POO called for replacing at least 20 inches on pit floors if possible. This was revised in 1995. For all pits still to be reclaimed, 8 to 10 inches of type B and C soils would be placed on regraded slopes less than 2:1 (Schafer and Assoc. 1995).

2.2.1.3 Waste Rock Dump Reclamation

The waste rock dump slopes were originally approved to be regraded to 2:1 slopes with 10-foot benches every 60 to 100 feet with a 20 inch soil cover (1989 POO). The conceptual grading plan was revised in Schafer and Assoc. 1995 (Exhibits 1 and 2 in Schafer and Assoc. 1995). The inside portions of most benches would be lined with clay and tied into a drainage system to reduce the amount of infiltration into the waste rock dumps (CDM and Schafer and Assoc. 1995). Regrading was completed by CR Kendall per the approved plans between 1991 and 1995 (Schafer and Assoc. 1995).

Kendall Waste Rock Dump
Removal. The approved Operating Permit does not require removal of any material from the waste rock dump.

Regrading. The lower slopes of the Kendall waste rock dump were reclaimed at slopes up to 2:1 between 1991 and 1993 (1989 POO). Slopes reclaimed after 1994 were regraded between 2 and 2.5:1 slopes (Schafer and Assoc. 1995).

Reclamation cover design. The approved RPL cover system, as described above for the heap leach pads, Section 2.2.1.1, was placed on XX acres of the waste rock dump top in 1994 and 1995. The lower, steeper slopes reclaimed between 1991 and 1993 were covered with 20 inches of soil. The upper slopes were reclaimed with 8 inches of C type soil (Schafer and Assoc. 1995). A portion of the east slope, XX acres, has not been reclaimed pending determination of need for use of this waste rock in the RPL cover on the heap leach pads.

Muleshoe Waste Rock Dump
The Muleshoe waste rock dump occupies portions of headwaters of two drainages, Barnes-King Gulch to the south and South Fork Little Dog Creek to the north.

Removal. The approved Operating Permit does not require removal of any material from the waste rock dump.

Regrading. The waste rock dump was regraded to 3:1 or less in 1995 (Schafer and Assoc. 1995) except for the southeast face that was regraded to 2:1 between 1991 and 1993 (1989 POO).

<u>Reclamation cover design</u>

- <u>North Muleshoe waste rock dump</u>. The approved RPL cover system, as described above for the heap leach pads, Section 2.2.1.1, was placed on XX acres of the waste rock dump top in 1994 and 1995. The rest of the North Muleshoe waste rock dump, X acres, was reclaimed with 10 to 14 inches of soil in 1994 and 1995 (Schafer and Assoc. 1995).
- <u>South Muleshoe waste rock dump</u>. The approved RPL cover system, as described above for the heap leach pads, Section 2.2.1.1, was placed on XX acres of the waste rock dump top in 1994 and 1995. The southeast slope, X acres, was covered with 20 inches of soil prior to 1993 (1989 POO). The rest of the South Muleshoe waste rock dump, X acres, was reclaimed with 8 to 14 inches of soil in 1994 and 1995 (Schafer and Assoc. 1995).

Horseshoe Waste Rock Dump

<u>Removal.</u> The approved Operating Permit does not require removal of any material from the waste rock dump.

<u>Regrading.</u> The waste rock dump was regraded to 4:1 or less in 1993 (DSL 1993 EA, CR Kendall Jan 1993).

<u>Reclamation cover design.</u> All portions of the waste rock dump were reclaimed with 10 to 14 inches of soil in 1994 and 1995 (Schafer and Assoc. 1995).

2.2.1.4 Unsuitable Reclamation Materials

Neither the 1989 POO nor the 1995 Soil and Revegetation Plan identified any unsuitable reclamation materials. Some materials have been subsequently identified as potentially unsuitable material due to acid producing content of black shales, thallium content, or rock content (see Chapter 3, Table 3-XX).

2.2.1.5 Reclamation of Miscellaneous Disturbances

Disturbed Area Soil Cover.

The 1989 POO stated all areas with slopes less than 2:1 would be covered with 20 inches of soil. This was later revised to 8 to14 inches of type A, B or C soils would placed based on slope angle according to the 1995 Soils and Revegetation Plan for remaining unreclaimed areas (Schafer and Assoc. 1995). After soil placement, YY acres would be seeded and revegetated.

Infrastructure

<u>Buildings</u>. All buildings would be removed at closure when reclamation was completed (1989 POO, Schafer and Assoc. 1995). The areas would be regraded, soiled, and revegetated per the 1995 Soils and Revegetation Plan.

<u>Ponds</u>. All ponds would be removed at closure when reclamation was completed (1989 POO, Schafer and Assoc. 1995). The ponds would be drained, the sediment cemented, the liners folded in and buried, and the embankments regraded to backfill the ponds. The surface would then be soiled, and revegetated per the 1995 Soils and Revegetation Plan.

<u>Roads.</u> The public access road through the mine site would be rerouted at closure as shown on Figure 1-2 (1989 POO). Other roads would be ripped, regraded, soiled and seeded.

Comment [KJ10]: is there a newer air photo than 1995?

2.2.1.6 Soils and Revegetation

The reclaimed land use will be habitat for wildlife and grazing land for livestock.

Soils
The soil and revegetation plans in the 1989 POO were substantially modified in 1995. Regraded surfaces would be ripped prior to soil placement to help prevent soil slippage along slopes and to facilitate root penetration into waste material. The suitability of waste material as a plant growth medium was a consideration in the 1995 Soils and Revegetation Plan. Only 8 to 14 inches of topsoil would be used for reclamation. Following placement of soil, shallow (<18 inch) dozer basins and other erosion control measures would be implemented on slopes steeper than 3:1 to reduce erosion and provide microhabitats for seedling establishment. Organic matter content would be raised to a minimum of 2 percent by weight and nitrogen fertilizer would be added at a rate sufficient to ensure the C:N ratio is less than 30:1 by weight.

Flat areas with less than 10 percent slopes would receive the best quality, type A, soils with the highest organic matter and lowest coarse fragment content for the upper layer. Moderate slopes, between 10 and 33 percent, would receive medium quality, type B, soil, which contain lower organic matter content and more coarse fragments. Steeper slopes, from 33 to 50 percent, would be reclaimed with the coarsest soil available, type C, to decrease erosion and complement establishment of trees (Schafer and Assoc. 1995).

Revegetation
The 1989 POO contained two seed mixtures, one for grasslands and one for forested areas. Kendall would plant trees to establish the forested areas. This was revised in 1995. Five revegetation mixes were formulated based on slope, aspect, and soil depths and characteristics (Schafer and Assoc. 1995). Grasses would be planted on shallow slopes with deeper soils and trees would be established on steeper slopes with coarse soils (Exhibits 1 and 2 in Schafer and Assoc. 1995). Sites were categorized as being either moderate or harsh with appropriate forest and grassland mixes. Harsh site vegetation mixes were generally chosen for the upper parts of slopes, where thinner soils and lower infiltration rates result in less available soil moisture than in toe slope areas. Drainages and draws would be dominated by tree and shrub communities. Trees would be planted in strategic locations to serve as visual barriers to pits and break up large expanses of grass meadows. Trees would be planted on pit benches.

2.2.1.7.1 Water Treatment

The 1989 Plan of Operations did not envision the need for any water treatment other than cyanide neutralization with hypochlorite and land application disposal of neutralized process solutions during operations and closure. LAD was implemented during the Grayhall Resources bankruptcy in 1987 to dispose of neutralized cyanide process solutions. At that time, the LAD area was located on a forested hillside southwest of the heap leach pad 4. The next LAD event was in 1991 to dispose excess process water caused by excessive rainfall. The LAD area used in 1991 was slightly uphill of the site used in 1987. Over chlorination of the water killed the trees in this area. Hillside slumping occurred as a result of over saturation of the soils and death of the trees. High rainfall in 1993 led to the need to resume LAD between August and October 1993. Because of the slump in the 1987 and 1991 LAD sites, the LAD area was relocated into a tributary to Mason Canyon. [Add a LAD figure showing current and historic sites indicating years of use and type of water applied.] This same LAD area was used in 1996-97 to dispose of water captured in newly installed pumpback systems

Monitoring at KVSW-7 below the LAD area in 1994 indicated discharge to surface water from LAD into Mason Canyon. No further LAD of neutralized cyanide process water was allowed at this location. In 1997 CR began to handle excess process water using evaporators located on the heap leach pads or reverse osmosis water treatment followed by discharge to the pits. The RO brine was temporarily stored in the process ponds until 1999 when lack of storage capacity led to land application of a blend of brine and pumpback water on ______<where?>______________. RO was discontinued in 1999 due to brine management concerns. Since 1999 all LAD has occurred on reclaimed waste rock dumps or upgradient of the mine pits. Both process solution and mine drainage from pumpback systems are applied to these areas (Figure ____).

Baseline water quality and geochemical analyses did not include testing for thallium because Montana did not have standards for thallium at that time. CR Kendall began monitoring for thallium in 1994. Thallium levels exceeded standards in waste rock dump seepage and groundwater in the leach pad underdrain resulting in the construction of the pumpback systems in 1996 (CR Kendall May 1996). Operational water treatment using zeolite columns and reverse osmosis was permitted in August 1997 and treated water was discharged into the Kendall and Muleshoe pits (CR Kendall August 12, 1997, DEQ MR 97-003).

The current practice is to pump process valley underdrain water from TMW-26 to limit migration of the contaminants in groundwater. Groundwater below the waste rock dumps is intercepted by pump-back systems: KVPB-5 (South Fork Last Chance Creek), KVPB-2 (Barnes-King Gulch), and KVPB-6 (Little Dog Creek).

Water Quality Standards or MPDES Permit Limits.
At the direction of DEQ, CR Kendall applied for an MPDES permit in 1998. Subsequent to a public hearing, it was determined that an MPDES permit could not be issued at that time. Currently, CR Kendall Mine is operating under interim effluent guidelines imposed under an Administrative Order (DEQ 1998). [INSERT TABLE HERE WITH INTERIM EFFLUENT GUIDELINES]

Leach Pad Effluent.
Leach pad effluent contains elevated levels of cyanide, nitrate, thallium, arsenic, selenium, antimony, and soluble salts (see Table 3-Xa). Effluent from the heap leach pads gravity flows into Ponds 7 and 8. [DEVELOP FLOW CHART TO SHOW ROUTING OF ALL WATERS] The water is then pumped into Pond 2B, blended with water from KVPB-6 in South Fork Little Dog Creek and KVPB-2 in Barnes-King Gulch, and land applied on reclaimed areas and native ground (see Figure 2-XX LAD map). Leach pad effluent may also be treated by reverse osmosis and zeolite adsorption in the process plant and then discharged to the Kendall or Muleshoe pit. The zeolite treatment system consists of two large columns, formerly containing carbon used in gold recovery, that have been linked in series and packed with zeolite. The large columns can treat up to 1,000 gpm (CR Kendall, 1999). [CHECK WITH GLEN]

Leach Pad Underdrain Effluent.
Leach pad underdrain effluent contains elevated levels of cyanide, thallium, and selenium, (see Table 3-Xb). Leach pad underdrain water is routed to pump-back system TMW-26 and pumped up to the former process plant where it is treated for thallium using smaller zeolite

columns and discharged to the Kendall pit during the winter. In the summer, it is pumped to Pond 2B and land applied without pretreatment. [CHECK WITH GLEN]

Waste Rock Dump Seepage.
Waste rock dump seepage contains elevated levels of nitrate, thallium, arsenic, and selenium (see Table 3-Xc). Currently, waste rock dump seepage from pump-back systems KVPB-2 (Barnes-King Gulch) and KVPB-6 (South Fork Little Dog Creek) is blended with heap leach pad effluent and land applied from April through November. In the winter, seepage from KVPB-2 and KVPB-6 is stored in Ponds 2B, 7, or 8.

Waste rock dump seepage from pump-back system KVPB-5 (South Fork Last Chance Creek) is pumped to the former process plant, blended with underdrain effluent from TMW-26, treated in the smaller zeolite columns and discharged to the Kendall pit (May 1996 Revision, Revised July 1996). Between April and November this water may be land applied without zeolite treatment.

Comment [KJ11]: Get cite for documents

Reclamation of Treatment Facilities
[Check existing document to see what is proposed for Reclamation of pumpback wells and system.]

2.2.1.8 Stormwater

The 1989 stormwater drainage plan anticipated that stormwater management would only be needed until reclamation was completed (1989 POO). The stormwater plan was updated in 1995 with the Drainage and Sediment Control Plan (CDM and Schafer and Assoc. 1995) and Figure 2-X shows the approved drainage pattern for the process valley and the as-built drainage pattern for the rest of the mine site.

Channels were originally designed at the Kendall Mine Site to contain sediment from stormwater. Sediment containment was accomplished by installing Best Management Practice (BMP) measures designed to minimize and control erosion.

Routing.
Operationally, stormwater is routed across the mine site in drainage channels to settling basins below the waste rock dumps or mine pits (CDM and Schafer and Assoc. 1995). Any water overflowing settling basins would discharge to off-site drainages. After vegetation is established stormwater would no longer be channeled into the mine pits.

Drainage Channel Designs.
Benches on waste rock dumps and the heap leach pads will be left in place every 60 to 100 vertical feet to reduce slope length, retard erosion, provide drainage control, and to afford access for reclamation activities. The inside portion of most benches would be lined with pit-run shale and tied into a drainage system to reduce the amount of infiltration into the waste rock dumps and heap leach pads.

Stormwater leaving the waste rock dumps and heap leach pads enter rip-rapped drainage channels containing small settling ponds called step pools (CDM and Schafer and Assoc. 1995). The step pools are lined with pit-run shale. The step pools reduce energy and the erosive force of water. Sediment accumulates in the step pools. Water percolates through the step pools into the waste rock or native ground beneath. The settling basins are located in native ground at the end of the drainage channels (Figure 2-X) and slow the flow of water so sediment can settle out of stormwater. The longer water is retained in a basin, the more settling occurs. Typical stormwater channel design is shown in Figure X.

The importance of providing settling basins for stormwater at the mine site becomes less critical after vegetation is established. Prior to developing a good stand of vegetation, BMPs are the primary mechanism to reduce sediment discharge from the site. After establishment of vegetation, BMPs, such as step pools, would be less important.

Stormwater System Reclamation.
Under the 1989 Reclamation Plan, all drainage channels, except the drainage channel around the heap leach pad, and sediment traps would be reclaimed to original contour when no longer needed (1989 POO). Under the 1995 plan, all drainage system components, including step pools, would remain in place after reclamation and closure (CDM and Schafer and Assoc. 1995).

2.2.1.9 Historic Tailings

Tailings were produced by historic milling operations between 1900 and 1941 as described in Section 1.2.1. These tailings were discharged to Mason Canyon, Barnes-King Gulch, and Little Dog Creek (Figures 2-5, 2-6, 2-9).

On-site Tailings.
Tailings located upgradient of heap leach pad 4 remain in place beneath the process facilities. Under the 1989 Plan of Operations, all tailings were removed from portions of Mason Canyon where heap leach pad 4 was constructed. 57,000 cubic yards of Barnes-King Gulch tailings and 20,300 cubic yards of North Moccasin Syndicate tailings from Little Dog Creek (CDM 2004c) were used for the leach pad cushion layer or overliner and the bentonite clay-amended underliner. Some tailings within the permit boundary were excavated from Barnes-King Gulch and Little Dog Creek for use in the cushion layer or overliner. Additional tailings within Barnes-King Gulch and Little Dog Creek were buried beneath the Horseshoe and South Muleshoe waste rock dumps. Remaining tailings between the mine facilities and the permit boundary in Barnes-King Gulch and Mason Canyon were subsequently removed by CR Kendall in 1996? and deposited in mine pits or waste rock dumps. CR Kendall has no plans to move or remove any remaining on-site tailings.

Off-site Tailings.
Tailings down gradient of the permit boundary remain within Mason Canyon, Last Chance Creek, Barnes-King Gulch, and Little Dog Creek. CR Kendall has no plans or obligations to remove or reclaim off-site tailings beyond the permit boundary.

2.2.1.10 Stream Flow Augmentation

Augmentation is any action by CR Kendall to actively replace or supplement flows in any drainage. Augmentation was not anticipated in the 1989 Plan of Operations and in the 1995 Soils and Revegetation Plan. CR Kendall initiated pumpback of contaminated water in four drainages in response to a Notice of Violation of the Montana Water Quality Act (DEQ Feb 1996, CR Kendall 1996). In 1996, CR Kendall proposed to release clean groundwater from supply wells to ensure that water supplies were not diminished to downstream users, but it did not implement the plan. In the 1998/2000? Administrative Order, DEQ required replacement of water in Little Dog Creek and South Fork Last Chance Creek during the spring and summer months at volumes equivalent to that removed by the pumpback systems (CITE AO).

Currently, water is pumped from supply wells, WW-6 and WW-7, completed within a deep aquifer, (Piper. Swift or Reirdon), in the Little Dog Creek drainage. There is no approved reclamation plan for the decommissioning of these supply wells and the pumpback systems

South Fork Last Chance Creek.
The South Fork Last Chance Creek is augmented by periodic pumping from water supply well WW-6, which is conveyed by pipeline across the mine, and used to replace surface water flow within that drainage immediately below KVPB-5. The required volume is based on the volume pumped from KVPB-5 the previous year. Mason Canyon Spring was approved by DEQ to be piped to South Fork Last Chance Creek for additional augmentation but has not been approved by BLM (2001/2 Revision?).

Mason Canyon.
Currently, no water augmentation is provided to Mason Canyon.

Barnes-King Gulch.
Currently, no water augmentation is provided to Barnes-King Gulch due to the presence of historic tailings in the drainage downstream of the mine.

Little Dog Creek.
Augmentation of Little Dog Creek was required by administrative order in 1998. Little Dog Creek is augmented through a combination of spring discharge collected from Upper Little Dog Spring, artesian flow from well WW-7, and periodic pumping from well WW-7. Water at the spring is collected in a pond, upstream of the mine site, and is routed through a buried pipeline across the mine site to the Section 29 spring in the Little Dog Creek drainage (2001/2 Revision?).

Figure 2-14

And Exhibit 1 from Schafer and Assoc. 1995

RPL only on dump tops—get from Schafer and Assoc. 1995.

Mason Canyon Spring needs to be located correctly.

Add LAD areas on this map or create a current water management practices map

See if facilities can be label—each pit and dump

Remove “of” from South Fork Last Chance Creek

Label pumpback wells and where they go KVPB-2 and KVPB-6

Light blue text hard to see and read

2.2.2 Proposed Action

The proposed alternative for the CR Kendall mine was developed based upon the following:

- Detailed input from the Stakeholder Involvement Process (SIP) (Section 1.3 and Chapter 6).
- Review of the Best Available Technologies (CITE needed/Appendix?).
- Consideration of the water treatment needs resulting from each cover type (Appendix D).

2.2.2.1 Leach Pad Reclamation

Leach Pad Design and Operation

The leach pad design and operation is described in Section 2.2.1.1 and no changes are proposed under the Proposed Action.

Regrading

Regrading is described in Section 2.2.1.1 and no changes are proposed under the Proposed Action. The only additional regrading needed under the Proposed Action would be to construct benches for liner key trenches (places to anchor down the liner) to install an FML.

Reclamation Cover Design

After cyanide neutralization and regrading as described in Section 2.2.1.1, the heap leach pads would be covered with a barrier cover system (Figure 2-Y) using, from top to bottom:

- 14 inches of stockpiled soil and/or alternative approved borrow material with appropriate coarse fragment content and low thallium levels (type A or B soils depending on slopes),
- 6 inch upper cushion layer of soil or alternative approved borrow material with low thallium levels screened to less than ½ inch particle size to protect flexible membrane liner (FML),
- Drainage net with non-woven fiber on both sides,
- 40-mil agency-approved FML, textured on slopes, and
- Minimum 6-inch lower cushion layer of compacted to 80 percent Proctor historic tailings from Barnes-King Gulch or Little Dog drainages or alternative approved material screened to less than ½ inch. [DO WE NEED CLAY AMENDMENT OR DID HELP MODEL ELIMINATE IT?] The Barnes-King tailings were reportedly milled to less than ¼ inch size and would meet the specification requirements for cushion material under the FML.

Figure 2-Y shows a conceptual cross section of the proposed heap-leach pad cover.

The proposed barrier cover system was designed to route precipitation infiltrating through the soil layers to the geo-net drain layer and into the stormwater drainage channels. The placement of soil or approved borrow material would be based on coarse fragment content and slope angle as described for the No Action Alternative in Section 2.2.1.1.

The quantities of soil and approved borrow material required for the remaining reclamation to be done under the Proposed Action are presented in Table 2-3. To complete the barrier cover system, leach pad 3 would also need at least 12,907 CY of historic tailings or alternative approved material screened to less than ½ inch and leach pad 4 would also need at least 32,267 CY of historic tailings or alternative approved material screened to less than ½ inch.

Table 2-3
Proposed Action Soil or Approved BorrowRequirements

Type	Area (acres)[1]	Soil Thickness (inches)	Soil Requirement (CY)
Leach Pad 3	16	20	43,022
Leach Pad 4	40	20	107,556
Kendall Dump	53	6[2]	42,753
Muleshoe Dump	83	6[2]	66,953
Horseshoe Dump	21	6	16,940
Other disturbed areas (including portions of pits to be soiled)	40	8-14	64,533
Total	**253**		**281,525**

[1]Acres based on 2004 annual report

[2] The waste rock dump tops have been covered with a RPL type cap, which includes a 56-inch thick cover (12" pit-run shale, 12" Madison limestone drain rock, 18" waste rock with subsoil-like qualities, and 10-14" soil), the 6 inches of soil would be in addition to the existing cover system.

[3]The Horseshoe Waste Rock Dump was reclaimed with an 8- to14-inch soil cover depending on slope; the 6 inches of soil would be in addition to the existing cover system.

Comment [KJ12]: base soil depths and acreage for other disturbed areas on 1995 Soils and Revegetation map and recalculate volumes

Pad Liner System

The pad liner system design and construction is the same as described in Section 2.2.1.1. At closure, the liner system would not be perforated. Instead the effluent would continue to be routed by gravity flow to Ponds 7 and 8 and then to the passive water treatment system as described below in Section 2.2.2.7. The treated water would discharge to Mason Canyon.

Figure 2-1

Proof new version to see if it has these items.

Change title to Proposed Action and Alternative 1, Barrier Cover System for Heap Leach Pad

Figure 2-2

Thickness of spent ore up to 200′

Flexible membrane liner is PVC and how thick—different between pad 3 or 4?

Under liner is bentonite amended tailings

Gravel underdrain size of gravel,

Change leak detection system to underdrain/leak detection system

2.2.2.2 Pit Backfill and Reclamation

Kendall Pit

Reclamation of the Kendal Pit would be the similar to the No Action Alternative except that a portion of the pit would be partially backfilled with XX CY from north slope of the Kendall Waste Rock Dump and none of the RPL stockpiles would be removed. Only a small section of the pit wall, which ties into the other regraded areas, will be reduced. The backfill material would be placed to reduce any potential safety hazards on the south and east sides of the pit near the public access road. The backfilled material would be regraded to a 2:1 slope or less, covered with 8 inches of C type soils, and revegetated. XX acres of the Kendall pit would be reclaimed as rock faces and XX acres would be soiled, seeded and revegetated.

Comment [KJ13]: Check the Reveg report from guy from UT to make recommendations about slopes and drainage etc.

Haul Road Pit

Because of possible contamination from LAD, 6 inches of type C soils would be placed over the existing reclamation and reseeded. [VERIFY THALLIUM & SALT CONTENT LEVELS FROM SOIL TESTS FOR THIS REQUIREMENT. THIS IS A LOW PRIORITY COMMITMENT, LAST AREA TO FIX]

Barnes-King Pit

Reclamation of the Barnes-King Pit would be the same as described under the No Action Alternative in Section 2.2.1.2.

Muleshoe Pit

Reclamation of the Muleshoe Pit would be the same as described under the No Action Alternative in Section 2.2.1.2 except for areas with inadequate revegetation and areas potentially contaminated from LAD. Those areas would be covered with 6 inches of type C soils, seeded, and revegetated.

South Horseshoe Pit

South Horseshoe Pit would be reclaimed as described for No Action Alternative in Section 2.2.1.2.

Horseshoe Pit

Horseshoe Pit would be reclaimed as described for No Action Alternative in Section 2.2.1.2.

Cover Soil for All Pits

The depth and placement of cover soil in the portions of pits still to be reclaimed would be the same as approved in 1995 (Schafer and Assoc. 1995). Where revegetation is inadequate or where soils are contaminated by LAD, an additional 6 inches of type B or C soils or approved borrow materials would placed based on slope angle and seeded.

2.2.2.3.1 Waste Rock Dump Reclamation

Kendall Waste Rock Dump

Portions of the existing Kendall Waste Rock Dump are steep and poorly revegetated.

Removal. X CY would be removed from the upper east face. The removed material would be placed in Kendall Pit as described above in Section 2.2.2.2.

Regrading. The upper east slopes would be regraded to 2.5:1. After the removal of material to the Kendall Pit, some minor regrading would be needed prior to soil placement.

Reclamation cover design. Existing soil on the Kendall waste rock dump slopes and top would be salvaged during regrading if it was of suitable quality. After regrading, 8 inches of type C soil would be placed on the 2.5:1 slopes. Where revegetation is inadequate, an additional 6 inches of type A, B or C soils or approved borrow materials would be placed based on slope angle. If no soil had been placed in some areas of the waste rock dump, then 8-14 inches of type A, B or C soils or approved borrow materials would placed based on slope angle according to the 1995 Soils and Revegetation Plan (Schafer and Assoc. 1995). After soil placement, YY acres would be seeded and revegetated.

Muleshoe Waste Rock Dump

A large portion of the Muleshoe Waste Rock Dump has been used for LAD and is potentially contaminated.

Removal. No removal is proposed under the Proposed Action.

Regrading. No regrading is proposed under the Proposed Action.

Reclamation cover design. Where revegetation is inadequate or soil is contaminated by LAD, an additional 6 inches of type A, B or C soils or approved borrow materials would be placed based on slope angle.

Horseshoe Waste Rock Dump

Portions of the Horseshoe waste rock dump are inadequately revegetated. [Field verification needed]

Removal. The Horseshoe waste rock dump would be reclaimed as described for No Action Alternative in Section 2.2.1.3. No removal would be required under the Proposed Action.

Regrading. The Horseshoe waste rock dump would be reclaimed as described for No Action Alternative in Section 2.2.1.3. No regrading would be required under the Proposed Action.

Reclamation cover design. Where revegetation is inadequate, an additional 6 inches of type A, B or C soils or approved borrow materials would be placed over existing revegetation based on slope angle (Schafer and Assoc. 1995). After soil placement, YY acres would be seeded and revegetated.

2.2.2.3.2 Unsuitable Reclamation Materials

Any material that does not pass geochemical sampling criteria for soil or approved borrow material (Cite Criteria Section in Chapter 3) would be placed in either the Kendall or Muleshoe pits, or it could be used as a cushion layer for the heap leach pad cover system. Each truck load of reclamation materials would be field verified prior to placement using x-ray florescence (XRF) to quantify thallium levels.

2.2.2.5 Reclamation of Miscellaneous Disturbances

Disturbed Area Soil Cover

Reclamation of miscellaneous disturbed areas would be the same as described in Section 2.2.1.5 for the No Action Alternative.

Infrastructure

Buildings. Buildings needed for long-term water treatment would be maintained until water treatment is no longer needed and would then be removed as described in Section 2.2.1.5 for the No Action Alternative. All other buildings would be removed at closure as described in Section 2.2.1.5.

Ponds. Ponds needed for long-term water treatment would be maintained until water treatment is no longer needed and all but one pond would then be removed as described in Section 2.2.1.5 for the No Action Alternative. One pond would be retained as a source of water for fire control as requested by the rural fire district.

Roads. The public access road would be rerouted at closure as described in Section 2.2.1.5 for the No Action Alternative. Roads needed to access water treatment facilities would be left until water treatment is no longer needed and would then be reclaimed as described in Section 2.2.1.5. All other roads would be reclaimed as described in Section 2.2.1.5 during closure.

2.2.2.6 Soils and Revegetation

Soils

Soil handling and placement would be the same as described for the No Action Alternative in Section 2.2.1.6 and the 1995 Soils and Revegetation Plan (Schafer and Assoc. 1995). The physical classification of reclamation soils or approved borrow material by coarse fragment content into type A, B, or C soils would also remain the same.

Under the Proposed Action, reclamation soils or approved borrow materials would also be characterized according to their thallium content by XRF in the field and segregated accordingly (see Section 2.2.2.4). This should minimize thallium contamination of stormwater runoff into the drainages leaving the permit area and reduce thallium concentrations in vegetation.

An additional 6 inches of soil or approved borrow material with at least one percent organic matter content would be placed on areas where vegetation was marginal or where the soil had been contaminated by LAD (Prodgers 2001). If the vegetation is inadequate, the existing cover soil is not contaminated, and the replaced soil has less than one percent organic matter in the top 4 inches, then agency-approved organic matter would be incorporated into the top 4 inches. Fertilizer would be applied to the prepared bed prior to seeding.

Revegetation

The revegetation plan for the Proposed Action would be similar to that in the No Action Alternative in Section 2.2.1.6. Seed mixes and planting of trees and shrubs would be modified based on recommendations by R. Prodgers (August 2001). The agency proposed seed mixes and tree and shrub planting density and species planting rates are in Appendix X.

Comment [KJ14]: Comparative Coversoil Evaluation and Revegetation Recommendations. August 2001. R. Prodgers, Bighorn Environmental Sciences. Ed to review report and revise seed mix to include in new appendix.

2.2.2.7 Water Treatment

DEQ has reviewed water treatment technologies and has concluded that adsorption based media treatment systems are most appropriate for site conditions and to meet goals of the EIS (Appendix D). Some of the advantages of using adsorption based media and in-drainage treatment of process valley water include:

- A less complex way to restore drainage flows.

- No water pumping and associated maintenance under normal flows since all systems operate under gravity.
- Mixing of water sources from other drainages is eliminated, resulting in the need to treat only the contaminants of concern for that drainage (e.g., thallium and selenium).
- The systems would be designed with underground cells to provide a more natural appearance and to protect from freezing.
- When properly sized for expected flow conditions, passive adsorption cells have proven to be effective at removing metals to low levels over the range of flows and temperature variations expected (CITE NEEDED).

Comment [KJ15]: Have CR Kendall run a bench test to determine effectiveness of adsorptive media.

Water Quality Standards or MPDES Permit Limits

CR Kendall would have to obtain a MPDES permit from DEQ. Water discharging from the site would have to meet MPDES permit limits based on DEQ-7 standards for each drainage (75-5-301 et seq., MCA).

Leach Pad Effluent

Short Term Treatment

Following installation of the proposed water barrier cover system on the leach pads, it would take and undetermined amount of time for the existing leachate to drain from the heaps. DEQ estimates it would take less than 5 years for the discharge to reach a steady state. Existing water treatment practices, which include a combination of active treatment using zeolite columns and LAD, would be used as described in Section 2.2.1.X. Once the leach pads have reached a steady state, the long-term strategy would be employed.

Comment [KJ16]: CDM review the amount of time for short-term drain down.

Long-Term Treatment

All sources of process valley water including leach pad and underdrain effluent would be blended and treated using passive adsorption-based technology(s) located in the drainage below Pond 7 (New conceptual figure Revised 2-7). Treatment using this approach is considered feasible with the elimination of all but 0.01 gpm of the leach pad effluent due to the use of the water barrier cover system (Table 4-1). Treatment would be required only for thallium and selenium in 13.0 gpm of leach pad underdrain effluent. Based on historical water quality data, arsenic, nitrate, and cyanide concentrations of the leach pad underdrain effluent are expected to be below water quality standards. The average treatment flow is projected to be 13 gpm, while the peak flow, usually in May through June, is estimated to be 40 gpm.

Applying a passive treatment technology in the Mason Canyon drainage would include the following steps:

- Gravity flow of water from the TMW-26 collection cistern to the treatment cells.

- Thallium and selenium removal by routing water through treatment cells containing one or more types of adsorption media, such as iron-bearing adsorption materials and natural zeolites.
- Gravity discharge of treated water to Mason Canyon.

Passive adsorption treatment cells would be sized based on residence time and/or adsorption capacity to provide continuous treatment for five to 10 years before adsorption media replacement is required. The cells would be designed for below ground installation in an engineered structure. Pond 8 would likely be converted to part of the passive adsorption treatment system for Mason Canyon.

In the event flow exceeded the designed capacity of the cells during rain or snow event or when maintenance was required, water could be directed to Pond 7 for storage and released to the treatment cells at a rate, which the system could handle. Alternatively, excess heap leach underdrain effluent could be directed to an infiltration trench filled with zeolites.

Leach Pad Underdrain Effluent

Short Term Treatment

While the adsorption media cells are constructed during closure leach pad underdrain effluent would continue to be handled as described in No Action Alternative in Section 2.2.1.7. Once the adsorptive media cells were operational leach pad underdrain effluent would be routed to the cells and discharged to Mason Canyon.

Long-Term Treatment

After the heap leach pad is capped with the water barrier cover system and the heap leach pad effluent has reach steady-state flows, it would be mixed with the leach pad underdrain effluent in the adsorption media cells and discharged to Mason Canyon as described above.

Waste Rock Dump Seepage

All waste rock dumps would have downgradient, gravity-fed, groundwater collection system(s) and passive adsorption media treatment cells containing one or more types of adsorption media, such as iron-bearing adsorption materials and natural zeolites (Figure 2-7a-d revised for each drainage). These systems would all be constructed within the permit boundary, with the possible exception of a stock pond adjacent to Barnes-King Gulch.   Unless the historic tailings are removed from Barnes King Gulch, treated water would be piped to a downgradient stock pond or other facility at the landowner's request. Treated water from the remaining waste rock dumps would be discharged into their respective drainages. The current pump-back collection systems would be decommissioned after the passive adsorption systems have been constructed.

In case flows exceed cell design capacity, excess water from any of the passive adsorptive treatment systems would be allowed to overflow and discharge to an infiltration trench filled with zeolites or another method if approved through the MPDES permit.

Reclamation of Treatment Facilities
All water treatment facilities with the exception of buried passive adsorption cells would be removed and reclaimed with 8 to 14 inches of soil when discharge meets water quality standards or MPDES limits without treatment. Additional soil may be needed above the buried passive adsorption cells depending on the adequacy of the vegetation.

2.2.2.8 Stormwater

Routing
Stormwater routing for the Proposed Action would be the same as described in Section 2.2.1.8 for the No Action Alternative.

Drainage Channel Designs
The drainage channels would be redesigned to address erosion concerns identified by Reveg (2001). Existing channels would remain in place as designed except as noted below (Figure 2-4 revised). Portions of the channels would be replaced where they are leaking into underlying waste rock, where step pools are removed, and/or where the channel needs to be reconstructed for other reasons. Replaced channel reaches would be lined with a FML and covered with graded filter materials when over waste rock to minimize infiltration (Figure 2-new). For channels on native ground, the FML would not be needed. Channels placed over the reclaimed heap leach pads would be designed with graded filter materials to be constructed on top of the FML for the reclamation cover system. Graded filter materials are placed in a channel in layers beginning with a layer of fine materials and ending with a top layer of rip-rap sized materials (Figure 2-new [2-3 revised]). This system is designed to reseal after erosion events and minimize infiltration.

Wherever feasible, stormwater from natural ground above the mine site would be routed to lined stormwater drainage channels for conveyance across the mine site. This includes ephemeral draws north of the Kendall Pit, south of the Barnes-King Pit, and west of the Muleshoe Waste Rock Dump.

Stormwater System Reclamation
Reclamation of the stormwater system would be the same as described in section 2.2.1.8 for the No Action Alternative except that step pools would be removed from existing channels where appropriate to minimize infiltration into waste rock and the channel would be reconstructed as described above under Drainage Channel Design.

2.2.2.9 Historic Tailings

The distribution of historic tailings is described in Sections 1.2.1 and 2.2.1.9.

On-site Tailings
Under the Proposed Action, as with the No Action Alternative, there are no plans to remove any remaining on-site tailings. All remaining on-site tailings are buried under modern mining waste rock dumps and process facilities.

Off-site Tailings

Accessible off-site tailings from Little Dog Creek and Barnes-King Gulch would be placed on the heap leach pads as cushion material beneath the FML of the barrier cover system (Figure 2-XX). CR Kendall must agree to the use of off-site tailings for the cushion material under the FML as allowed under MEPA (GET CITATION) and obtain landowner consent to remove any off-site tailings. The disturbance created by removing historic tailings would be regraded, ripped, and revegetated using an agency and landowner approved seed mix.

Figure 2-3

Redo ditch based on cases discussed on figure 2-4 and below

Not listed as cases anymore.

Do in black and white, use more natural-looking textures/patterns

Channels not ditches

1. new or reconstructed channels with FML on heap leach pad and waste rock dumps (may need 2 cross sections)
2. new or reconstructed channels on native ground
3. existing channels not to be reconstructed

Provide detail on cross section to show layers

Label cross section or longitudinal section

Don't show water in step pools or keep very shallow, make a note not to scale, sho

Sent ore to "spent ore"

Existing channel design prior…. For second para

No bentonite amended soil—use graded filter materials

Figure 2-4

Use new air photo

Use 11x 17 if needed Would a topo map make it cleaner?

1. new or reconstructed channels with FML on heap leach pad and waste rock dumps (may need 2 cross sections)

2. new or reconstructed channels on native ground

3. existing channels not to be reconstructed

Show areas to be regraded on Kendall dump and backfilled in Kendall pit

Show areas to be resoiled on Kendall dump and pit

Remove Pond 8 and call it passive adsorption system w/contingency site below

Show areas to be regraded on South Muleshoe Dump and backfilled portion of Muleshoe pit

Make text consistent w/decisions in field for regrades, additional soil placements, and acreages—check texts too.

Miscellaneous areas in gray reclaimed as per 1995 plan.

Add settling basins

Legend for colors on map

Historic not historical, Soil not topsoil

Look at comments from Figure 2-14:

RPL only on dump tops—get from Schafer and Assoc. 1995.

Mason Canyon Spring needs to be located correctly.

Add LAD areas on this map or create a current water management practices map

See if facilities can be labeled—each pit and dump

Remove "of" from South Fork Last Chance Creek

Label pumpback wells and where they go KVPB-2 and KVPB-6

Light blue text hard to see and read

Figure 2-5

Change title to "Current Distribution of Historic Tailings"

Remove historic tailings from under heap leach pad 4, and other areas—ask Wayne

Make red areas match those on 2-4 or vise versa Use whichever are correct.

Figure 2-7a-d

Needs to be specific for each waste rock dump;

another one should be developed for Mason Canyon.

Show a buried gravel drain system (v-shaped) with perforated pipe below the waste rock dump (refer to design shown in CR Kendall 1996).

Make this a black and white figure

****

Heap leach figure:
Show the underdrain system representative of actual design.
Show water being routed to TMW-26
Separate heap leach effluent and underdrain effluent systems.
Black and white figure
Show routing back to Pond 7 and cells in Pond 8
Show discharge to Mason Canyon

2.2.2.10 Stream Flow Augmentation

Water augmentation to drainages is incorporated in the Proposed Action to account for reduced surface water flows because of increased groundwater recharge due to mine disturbance. Improved storm water channel design would provide for more surface flows. Passive adsorption treatment of process valley effluent and waste rock dump seepage would return water to each drainage as described above.

South Fork Last Chance Creek

Under the Proposed Action, treated waste rock dump seepage would be returned to South Fork Last Chance Creek as described under Section 2.2.2.7. In addition, Mason Canyon Spring would be used for augmentation as described in Section 2.2.1.10 for the No Action Alternative, but BLM approve would still be required.

Mason Canyon

During mine life, all precipitation falling on the heap leach pads has been captured in the process circuit. The heap leach effluent was either land applied, evaporated, or discharged to the pits. Under the Proposed Action, Mason Canyon would receive stormwater runoff water from the reclaimed heap leach pads as well as treated heap leach effluent and heap leach underdrain effluent as described in Section 2.2.1.10. No augmentation would be provided.

Barnes-King Gulch

Under the Proposed Action, treated waste rock dump seepage would be returned to Barnes-King Gulch as described under Section 2.2.2.7. If historic tailings in Barnes King Gulch are not removed, treated seepage would be routed to a stock tank and a percolation pond. No additional augmentation is proposed.

Little Dog Creek

Under the Proposed Action, treated waste rock dump seepage would be returned to Little Dog Creek as described under Section 2.2.2.7. In addition, Upper Little Dog Spring would be used for augmentation as described in Section 2.2.1.10 for the No Action Alternative.

Figure 2-8

Kendall Dump regrade

Move up and may need to revise

Move to Chapter 3

Figure 2-10
North Fork of Little Dog Creek tailings prior to modern mining activities (October 1974).

2.2.3 Alternatives to the Proposed Action

Two alternatives to the Proposed Action were developed to primarily address water quality concerns.

- Alternative 1 is similar to the Proposed Action except the North Muleshoe Waste Rock Dump would be capped with a barrier cover system.

- Alternative 2 is similar to the Proposed Action except the heap leach pads would be covered with a 36-inch soil cover system and the North Muleshoe Waste Rock Dump would be removed and backfilled into the Muleshoe Pit.

2.2.3.1 Muleshoe Waste Rock Dump Reclamation Alternative (Alternative 1)

2.2.3.1.1 Leach Pad Reclamation

Leach pad reclamation in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.1.

2.2.3.1.2 Pit Backfill and Reclamation

Pit backfill and reclamation in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.2.

2.2.3.1.3 Waste Rock Dump Reclamation

Waste rock dump reclamation in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.3 except for the Muleshoe Waste Rock Dump.

Muleshoe Waste Rock Dump

- Removal. As with the Proposed Action, no removal of the Muleshoe Waste Rock dump would occur.

- Regrading. As with the Proposed Action, no regrading of the Muleshoe Waste Rock dump would occur.

- Reclamation cover design. Portions of the South Muleshoe Waste Rock Dump would be reclaimed as described in the Proposed Action in Section 2.2.2.3. Any soils that were on the North Muleshoe Waste Rock Dump would be salvaged prior to placement of the barrier cover system. Minor recontouring would be needed after soil removal on the North Muleshoe Waste Rock Dump and before placement of the barrier cover system. The barrier cover system for the dump would be the same as that described for the heap leach pads in the Proposed Action, Section 2.2.2.1. See Figure 2.12. [this is similar the heap leach barrier cover fig but for waste rock dump] To complete the barrier cover system, the North Muleshoe Waste Rock Dump would also need at least XX,XXX CY of historic tailings or alternative approved material screened to less than ½ inch. The barrier cover system for this dump would result in changes in the amount of soil or approved borrow material needed for reclamation under Alternative 1 (see Table 2-7)

Table 2-7
Alternative 1 Soil and Approved Borrow Requirements

Type	Area (acres)[1]	Soil Thickness (inches)	Soil Requirement (CY)
Leach Pad 3	16	20	43,022
Leach Pad 4	40	20	107,556
Kendall Dump	53	6[2]	42,753
North Muleshoe Dump	83	20	66,953
South Muleshoe Dump	XX	6[2]	XX,XXX
Horseshoe Dump	21	6[3]	16,940
Other disturbed areas (including portions of pits to be soiled)	40	8-14	64,533
Total	**253**		**281,525**

[1]Acres based on 2004 annual report

[2] The waste rock dump tops have been covered with a RPL type cap, which includes a 56-inch thick cover (12" pit-run shale, 12" Madison limestone drain rock, 18" waste rock with subsoil-like qualities, and 10-14" soil), the 6 inches of soil would be in addition to the existing cover system.

[3]The Horseshoe Waste Rock Dump was reclaimed with an 8- to14-inch soil cover depending on slope; the 6 inches of soil would be in addition to the existing cover system.

Comment [KJ17]: base soil depths and acreage for other disturbed areas on 1995 Soils and Revegetation map and recalculate volumes

2.2.3.1.4 Unsuitable Reclamation Materials
The identification and placement of unsuitable reclamation materials in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.4.

2.2.3.1.5 Reclamation of Miscellaneous Disturbances
Reclamation of miscellaneous disturbances in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.5.

2.2.3.1.6 Soils and Revegetation
Soil handling and placement and revegetation in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.6.

2.2.3.1.7 Water Treatment

Water treatment in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.6 although a smaller passive treatment cell would be needed below the North Muleshoe Waste Rock Dump.

2.2.3.1.8 Stormwater

Stormwater management and routing in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.8.

2.2.3.1.9 Historic Tailings

The reclamation and use of historic tailings in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.9 except that off-site historic tailings would be used as cushion material beneath the FML of the barrier cover system on the North Muleshoe Waste Rock Dump. As with the Proposed Action, CR Kendall must agree to the use of off-site tailings for the cushion material under the FML as allowed under MEPA (GET CITATION) and obtain landowner consent to remove any off-site tailings.

2.2.3.1.10 Stream Flow Augmentation

Stream flow augmentation in Alternative 1 would be the same as described for the Proposed Action in Section 2.2.2.10.

2.2.3.2 Muleshoe Pit Backfill and Leach Pad Soil Cover Alternative (Alternative 2)

2.2.3.2.1 Leach Pad Reclamation

Leach Pad Design and Operation

The leach pad design and operation is described in Section 2.2.1.1 and no changes are proposed under Alternative 2.

Regrading

Regrading is described in Sections 2.2.1.1 and no changes are proposed under Alternative 2. The only regrading needed would be to construct benches for liner key trenches (places to anchor down the liner) to install an FML in stormwater drainages.

Reclamation Cover Design

No barrier cover system is proposed for Alternative 2. The heap leach pads would be covered with a minimum 36-inch cover soil system (Figure 2-??) using, from top to bottom:

- Minimum 20 inches of stockpiled soil and/or alternative approved borrow material with appropriate coarse fragment content and low thallium levels (type A or B soils depending on slopes),
- 16 inches of soil and/or alternative approved borrow material with marginal thallium levels.

The soil or approved borrow material requirements for Alternative 2 are provided in Table 2-8.

Table 2-8
Alternative 2 Soil or Approved Borrow Requirements

Type	Area (acres)[1]	Soil Thickness (inches)	Subsoil Thickness (inches)	Soil Requirement (CY)
Leach Pad 3	16	20	16 (min)	77,440
Leach Pad 4	40	20	16 (min)	193,600
Kendall Dump	53	6[2]	N/A	42,753
South Muleshoe Dump	83	6[2]	N/A	66,953
North Muleshoe Dump footprint	XX	0-14	N/A	XX,XXX
Horseshoe Dump	21	6[3]	N/A	16,940
Other disturbed areas (including portions of pits to be soiled)	40	8-14	N/A	64,533
Total	**253**			**462,219**

[1]Acres based on 2004 annual report

[2] The waste rock dump tops have been covered with a RPL type cap, which includes a 56-inch thick cover (12" pit-run shale, 12" Madison limestone drain rock, 18" waste rock with subsoil-like qualities, and 10-14" soil); the 6 inches of soil would be in addition to the existing cover system.

[3]The Horseshoe Waste Rock Dump was reclaimed with an 8- to14-inch soil cover depending on slope; the 6 inches of soil would be in addition to the existing cover system.

Pad Liner System

As with the Proposed Action, the liner system would not be perforated. The management and routing of effluent in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.1.

2.2.3.2.2 *Pit Backfill and Reclamation*

Pit backfill and reclamation in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.2 except for the Muleshoe Pit.

Muleshoe Pit

The North Muleshoe Waste Rock Dump, XX CY, would be backfilled into the Muleshoe Pit and graded to a XX percent slope toward Little Dog Creek (Figure XXX). If necessary, the east wall of the pit would be cut to establish a free-draining surface out of the pit. A berm would be built adjacent to the highwall to prevent stormwater from pit highwall from contaminating the reclaimed surface of the backfill. The XX acres of the backfilled Muleshoe Pit would be covered with 8 to 10 inches of type B or C soils or approved borrow materials would placed based on slope angle and seeded.

2.2.3.2.3 Waste Rock Dump Reclamation
Waste rock dump reclamation in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.3 except for the Muleshoe Waste Rock Dump.

Muleshoe Waste Rock Dump

- Removal. The entire North Muleshoe Waste Rock Dump, XX CY, would be removed and backfilled into the Muleshoe Pit (Figure 2-XXX). The South Muleshoe Waste Rock Dump would remain in place.
- Regrading. The land beneath the North Muleshoe Waste Rock Dump would be returned to premine contours. There would be no regrading on the South Muleshoe Waste Rock Dump.
- Reclamation cover design. The South Muleshoe Waste Rock Dump would be reclaimed as described for the Proposed Action in Section 2.2.2.4. After the North Muleshoe Waste Rock Dump was removed, YY acres of exposed soils left would be tested for thallium. In areas with low levels of thallium, the ground would be ripped and seeded. In areas with elevated thallium levels or areas where all soil had been removed, 8 to 14 inches of type A, B or C soils or approved borrow materials would be placed over ripped soils based on slope angle (Schafer and Assoc. 1995). The replaced soils would be seeded and revegetated.

2.2.3.2.4 Unsuitable Reclamation Materials
The identification and placement of unsuitable reclamation materials in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.4.

2.2.3.2.5 Reclamation of Miscellaneous Disturbances
Reclamation of miscellaneous disturbances in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.5.

2.2.3.2.6 Soils and Revegetation
Soil handling and placement and revegetation in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.6.

2.2.3.2.7 Water Treatment
Alternative 2 water treatment is similar to the proposed alternative except that additional treatment technologies would be needed to treat cyanide, nitrate, and arsenic present in the heap leach effluent.

Water Quality Standards or MPDES Permit Limits

Water quality standards or MPDES permit limits for each drainage would be the same as described for the Proposed Action.

Leach Pad Effluent

As a consequence of using a cover soil system on the heap-leach pads, long-term water treatment would be required to treat an average 4 gpm (19 gpm during spring peak flow) of leach pad effluent in addition to the average 13 gpm of underdrain effluent (peak of 40 gpm). The underdrain effluent would have to be pumped to Pond 7 to mix with the leach pad effluent. Based on historic water quality, leach pad effluent has relatively high concentrations of nitrate, thallium, selenium, arsenic and cyanide compared to underdrain effluent and waste rock dump seepage. Heap leach effluent would require multiple treatment steps to meet discharge standards. Leach pad effluent and underdrain effluent would be treated in a passive flow system within Mason Canyon and would consist of the following treatment steps:

- Collection of heap leach pad effluent and underdrain effluent in Pond 7.
- Adding hydrogen peroxide to Pond 7 to remove cyanide.
- Gravity flow of water from Pond 7 to a passive flow zeolite treatment cell for thallium removal.
- Semi-passive treatment of the zeolite effluent in an anaerobic biotreatment cell with methanol addition.
- Passive treatment in an iron-media adsorption cell for arsenic and selenium removal.
- Gravity discharge of treated water to Mason Canyon.

Leach Pad Underdrain Effluent

Leach pad underdrain effluent would be pumped, mixed, and treated with leach pad effluent as described above.

Waste Rock Dump Seepage

Water treatment in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.7 although a smaller passive treatment cell would be needed below the reclaimed area where the North Muleshoe Waste Rock Dump was removed.

Reclamation of Treatment Facilities

The reclamation of treatment facilities once they are no longer required would be the same as described for the Proposed Action under 2.2.2.7.

2.2.3.2.8 Stormwater

Routing

Routing of stormwater under Alternative 2 would be the same as the Proposed Action except that a lined stormwater channel would be constructed to drain stormwater from the backfill in the Muleshoe Pit through a key cut to South Fork Little Dog Creek. A berm would be constructed below the highwall to prevent runoff from contaminating soils on the pit backfill.

Drainage Channel Designs

Drainage channel designs would be the same for Alternative 2 as described under the Proposed Action in Section 2.2.2.8.

Stormwater System Reclamation

Stormwater system reclamation would be the same for Alternative 2 as described under the Proposed Action in Section 2.2.2.8.

2.2.3.2.9 Historic Tailings

The reclamation of on-site historic tailings would be the same as described under the No Action Alternative in Section 2.2.1.9. The removal of off-site historic tailings would be the same as described for the Proposed Action in Section 2.2.2.9. The tailings would be placed in the Muleshoe Pit along with the backfill from the North Muleshoe Waste Rock Dump. As with the Proposed Action, CR Kendall must agree to the use of off-site tailings for backfill as allowed under MEPA (GET CITATION) and obtain landowner consent to remove any off-site tailings.

2.2.3.2.10 Stream Flow Augmentation

Stream flow augmentation in Alternative 2 would be the same as described for the Proposed Action in Section 2.2.2.10.

Figure 2-12

Figure 2-13

2.3 Alternatives and Components Eliminated From Further Consideration

The following alternatives and components were eliminated from further consideration as a result of applying the screening criteria in Section 2.1:

- Backfill the pits with waste rock from the dump and tailings beneath the dumps to eliminate highwalls and create free-draining conditions for all pits.
- Backfill the pits with enough waste rock to eliminate highwalls and create free-draining conditions for all pits with liners above and below the backfill with leachate collection.
- Remove the spent ore from the heap leach pads and backfill into the pits, with FMLs above and below the backfill with leachate collection.
- Place geocomposite clay liner (GCL) type covers on the heap leach pads, waste rock dumps, and/or backfilled pits.
- Place composite reclamation covers (GCL overlain by FML and a drainage layer) on the heap leach pads, waste rock dumps, and/or backfilled pits.
- Place combination of barrier and water balance reclamation cover systems on the heap leach pads, waste rock dumps, and/or backfilled pits.
- Place barrier cover systems on waste rock dumps and/or backfilled pits.
- Treat mine waters using a reverse osmosis (RO) system.
- Treat mine waters using an ion exchange (IX) system.
- Treat mine waters using chemical precipitation.
- Treat mine waters using biological treatment systems.
- Treat mine waters using sustained LAD for primary water treatment.
- Blend untreated mine waters of varying qualities for use by livestock.
- Augment surface water flow with groundwater supply wells.
- Remove all on-site and off-site historic tailings.

2.3.1 Waste Rock Dump/Tailings Removal to the Pits

The waste rock dumps and any historical tailings beneath the dumps could be used as backfill in the pits. Nearly all the waste rock and tailings (XX,XXX CY), about XX percent, could be placed in the pits as long as the heap leach pad remained in place (Table 2-X). This would leave about XX,XXX CY of waste rock to be reclaimed in place. [GET ESTIMATE OF TAILINGS UNDER WASTE ROCK DUMPS—CR KENDALL.]

~~Completely backfilling the pits with waste rock is probably not implementable. Because the pits were excavated from a hillside with a rather steep slope, complete backfill would require placing waste rock at a steep angle. The waste rock would have to be piled up against the highwalls and would be unstable and subject to landslides. In addition, the waste rock would be too steep to hold a cover. (~~REPLACE WITH A BRIEF SUMMARY and cite THE BACKFILL DRAWINGS.)

Sources of mine wastes in each drainage must be completely eliminated for any removal to be effective in meeting water quality goals. Those sources include historic tailings, waste rock, and any native materials that have been contaminated by poor quality water. Assuming that most of the waste rock, underlying tailings, and contaminated materials could be removed, water treatment would still be needed to meet water quality discharge standards for a period of time. Complete removal is unlikely because the sand-sized or smaller tailings are probably mixed with the native sediments in the drainages since tailings have been in those drainages for over 100 years. In addition, low quality water that has been produced by the waste rock and tailings has likely affected the native sediments over the years. Given the low surface water standards for thallium (0.0017 mg/L), arsenic (0.018 mg/L), and selenium (0.005 mg/L for chronic aquatic), slightly elevated post-removal levels in the sediments within the drainages could result in surface water concentrations exceeding WQB-7 standards (CITE NEEDED).

Wells completed in 2004 within the Kendall and Muleshoe waste rock dumps indicate that the bases of these waste rock dumps are not in contact with the groundwater table (See Appendix A for the well locations and completion logs) (CDM 2004a). The project objective of limiting groundwater and mine waste interactions could be met without relocating the waste rock to the pits.

Effectiveness	
Adverse Impacts	
Implementability	
Consequences of failure	
Reliability	
Reasonableness	
Cost	

2.3.2 Complete Pit Backfill with Liners and Leachate Collection

The primary objective of limiting migration of low quality leachate into the groundwater could be met by lining the pits prior to backfilling, capping the backfill with a liner system, and then collecting the leachate for treatment. Before liners could be placed in the pits, waste rock overlain by a cushion layer of finer material such as subsoil or historic tailings would need to be added to provide the appropriate slopes (3:1) to hold the liners. This is a geotechnical requirement for all types of liners including bentonite clay amended liners. Since the purpose of this alternative is to encapsulate all waste rock, placement of additional waste material beneath the lower liner would defeat the purpose. The quantity of appropriately sized subsoil with low leaching potential is limited on site and using it for the cushion material or to achieve desired slopes beneath the lower liner would be an inefficient use of resources.

Capping the backfill with a barrier cover system would preclude more than 99 percent of the infiltration into the backfill (Appendix B). As the pits are located above the water table, there would be no potential for groundwater to flow laterally into the backfill, become contaminated by the waste rock, and flow into the aquifer beneath the pit. There would be little need for a leachate collection system using the barrier cover system with or without a lower liner. The lower liner would provide no additional protection if the barrier cover system were used. There would be little benefit to using only the lower liner because this would result in contaminating a larger amount of water reaching the lower liner. The leachate collected above the lower liner would provide an additional source of water requiring long-term water treatment.

2.3.3 Leach Pad Removal

The removal of XXXXX million CY of spent ore from the heap leach pads could be used to backfill the Kendall (XXXXX CY), Barnes-King (XXXXX CY), and a portion of Muleshoe (XXX CY) pits (Table 2-X). Complete backfill of the pits would require additional waste rock, but would not allow removal of all waste rock dumps. The spent ore is contained on synthetic liners with a seepage collection system described in Section 2.2.2.1. Relocating the spent ore into several pits would require constructing similar containment facilities to that already in place. To install a liner system beneath the spent ore in each pit, waste rock and cushion materials would be needed to provide the appropriate slopes (3:1) to hold the liners as described in Section 2.3.2. The rationale for not using liners in the pits beneath spent ore and not using limited good quality reclamation resources beneath the liners would be the same as described above in Section 2.3.2 for placing mine waste rock in the pits.

Current data for the underdrain effluent below the underliner shows nitrate/nitrite concentrations averaging about 6 mg/L, while the heap leach pad effluent above the underliner, as measured in the pregnant pond, averages over 100 mg/L nitrate/nitrite (CITE CRK 2004 annual report). The nitrate/nitrite concentrations in the underdrain effluent are consistent with the other drainages on site. This indicates that the high nitrate/nitrite heap leach pad effluent is not leaking through the underliner. The results for other parameters such as thallium are consistent with the nitrate/nitrite results, with average thallium concentrations of 0.026 mg/L and 0.807 mg/L for the underdrain and heap leach pad effluent, respectively.

CR Kendall regraded the heap leach pads in the summer of 2004, inspected the exposed portions of the underliner, made repairs to the edges of the underliner damaged by erosion and sunlight, and extended the underliner to allow placement of some of the regraded spent ore between heap leach pads 3 and 4. The 2004 construction reports document that the liner is in good condition and that all of the spent ore is on the liner (Womack and Assoc. 2004). The protectiveness of the existing liner was the primary reason why the stakeholders concurred that there was no beneficial reason to move the spent ore from the pads when the issue was discussed during the stakeholder involvement process (CDM 2004b)

2.3.4 GCL Covers for Heap Leach Pads, Waste Rock Dumps and/or Backfilled Pits

Geosynthetic clay liners (GCL) are used extensively for waste containment to limit seepage for both underliners and in reclamation barrier cover systems (Figure 3, Option 3, in Appendix B). GCLs contain a clay layer designed to be self-healing if the GCL is installed properly in the appropriate environment. At the Kendall Mine, a GCL reclamation cover system could be used on the heap leach pads, waste rock dumps, and/or the backfilled pits. This reclamation barrier cover system would require from top to bottom:

- 14 inches of stockpiled soil and/or alternative approved borrow material with appropriate coarse fragment content and low thallium levels (type A or B soils depending on slopes),
- 6 inch upper cushion layer of soil or alternative approved borrow material with low thallium levels screened to less than ½ inch particle size to protect the GCL
- Drainage net with non-woven fiber on both sides,
- Agency-approved GCL, and
- Regraded compacted spent ore or a minimum 6-inch lower cushion layer of compacted to 80 percent Proctor historic tailings from Barnes-King Gulch or Little Dog drainages or alternative approved material screened to less than ½ inch over waste rock.

GCLs, especially in semi-arid climates, tend to dry out and desiccate, which forms fractures in the clay layer that can transmit water (Richardson 1994). There is often insufficient water for the clay to completely reseal before some seepage through the liner occurs. The problem is made worse by the presence of calcium in infiltration water, which can exchange with sodium in the clay (CITE paper from Patrick). The sodium clays expand when wet, filling fractures. When the sodium in the clay is replaced by calcium, the expansive properties are reduced. Calcium is abundant in all waste and reclamation materials at the mine site. All water at the site is high in calcium (CR Kendall 2004). Limiting contact of calcium-rich water with a GCL at the mine would not be possible.

Comment [KJ18]: short course at Mine Closure and Design Conference 2004

GCLs placed in the frost zone in cold climates, freeze and thaw and desiccate, which forms fractures in the clay layer that can transmit water. GCLs would need to be placed at least 6 feet deep at the Kendall Mine to avoid this potential problem (CITE NEEDED) . This depth requires a larger quantity of reclamation materials for the cover system that are limited at the site. FMLs would achieve the same objective of limiting seepage without the problems faced by GCLs at the Kendall Mine.

2.3.5 Composite reclamation covers for heap leach pads, waste rock dumps, and/or backfilled pits

Composite covers consist of a FML, the primary liner, underlain by a GCL or low permeability, often bentonite-amended, earthen material (Figure 3, Option 4, in Appendix B). The composite cover provides a secondary barrier layer, designed to seal itself if there is minor damage to the primary liner. At the Kendall Mine, a composite reclamation cover system could be used on the heap leach pads, waste rock dumps, and/or the backfilled pits. This composite reclamation barrier cover system would require from top to bottom:

- 14 inches of stockpiled soil and/or alternative approved borrow material with appropriate coarse fragment content and low thallium levels (type A or B soils depending on slopes),
- 6 inch upper cushion layer of soil or alternative approved borrow material with low thallium levels screened to less than ½ inch particle size to protect the FML,
- Drainage net with non-woven fiber on both sides,
- Agency-approved FML,
- Agency-approved GCL or bentonite-amended earthen material, and
- Regraded compacted spent ore or a minimum 6-inch lower cushion layer of compacted to 80 percent Proctor historic tailings from Barnes-King Gulch or Little Dog drainages or alternative approved material screened to less than ½ inch over waste rock.

These covers are typically used at sites where it is critical to minimize leachate production, such as solid and hazardous waste landfills, or acid producing wastes, such as abandoned or closed mine waste facilities. Composite reclamation covers are typically used where capital costs of the cover have been weighed favorably against potential treatment cost for leachate or other risk factors, such as nearby human or environmental receptors. Numerous applications of composite covers at Montana landfills and other locations across the United States have been reviewed (Appendix B). Modelling does not indicate substantial differences in leachate production a between composite reclamation cover system and single liner reclamation cover systems. For example, on the tops of heap leach pads, the volume of water that would penetrate the composite cover was less than 0.01 gpm compared to the amount that would penetrate a single FML (0.01 gpm) or a GCL (0.02 gpm). The composite cap was eliminated from further analysis because there would be no additional benefit to adding a second liner to the reclamation barrier system.

2.3.6 Combination of reclamation cover systems for heap leach pads, waste rock dumps, and/or backfilled pits

Another alternative considered for closing the heap leach pads, waste rock dumps, and/or backfilled pits was using a combination of reclamation cover systems (Figure 3, Option 5,

Appendix B). The objective of using a combination of reclamation cover systems would be to place an impermeable barrier cover system in flat areas where infiltration was likely to be greater and use a water balance reclamation cover on sloped areas where runoff was more likely to occur.

In Montana, spring snowmelt can be significant and can take place when evaporation and transpiration are minimal. For instance, the Basin Creek Mine[3] placed an impermeable barrier cover over its heap leach pads where drifting snow is not completely melted until mid June (CITE EPA? REPORT). During the period when snow melts and percolates into the soil, evapotranspiration is insignificant. For a water balance cap to properly function and minimize leachate production, water must be stored in the soil so it does not percolate through the waste.

Another advantage of using a combination of reclamation cover systems is that it allows soil to be placed on the steeper slopes for stability where liners could be more difficult to install. Modeling for a combination of reclamation cover systems was conducted for the Kendall Mine heap leach pads (Appendix B). A combination of reclamation cover systems on the heap leach pads would produce an average of 4.2 gpm of leachate with a maximum of 14.7 gpm in the spring (Table 2, Appendix B). Modeling showed that to reduce the flow of water into the spent ore so that water treatment would not be needed, an FML barrier cover system would need to be installed on the top and slopes. This barrier cover system would produce a maximum of 0.03 gpm leachate (Ibid.). If a combination of reclamation cover systems were to be used, leachate would still be generated and water treatment would be necessary below the heap leach pads and the waste rock dumps. Most of the waste rock dump slopes do not need totally new reclamation covers, although they may need to be supplemented. The agency has included provisions for additional soil on waste rock dump slopes in all action alternatives.

2.3.7 Barrier cover systems for waste rock dumps and/or backfilled pits

Barrier cover systems could be installed on waste rock dumps and/or backfilled pits to minimize seepage and eliminate water treatment. The barrier cover systems would be constructed as described for the heap leach pads in the Proposed Action in Section 2.2.2.1.

A barrier cover system on the heap leach pads would reduce infiltration from a maximum of 18.9 gpm for a water balance cover system to 0.03 gpm (Table 2, Appendix B). Similar reductions in seepage could be expected if barrier cover systems were installed over waste rock dumps and/or backfilled pits. The majority of the waste rock dump tops and slopes have been reclaimed.

The agency reviewed water quality and quantity data from the seepage collection systems below the three dumps (Tables 2-X and 2-Y below). Capping the waste rock dumps with a barrier cover system would hinge on whether or not the seepage below the dumps could be treated passively to standards. The primary factors are the number and concentrations of the pollutants and the peak seepage discharge rate below each waste rock dump.

[3] The Basin Creek Mine is located on the Continental Divide at an elevation of XXXXX feet in Jefferson County, Montana.

Seepage from the Kendall Waste Rock Dump could be treated passively due to low contaminant concentrations and low flow rates. Seepage from the South Muleshoe Waste Rock Dump contains high levels of thallium but a low flow rate making passive treatment of the seepage possible. Seepage from the North Muleshoe Waste Rock Dump contains nitrates in excess of water quality standards, which would require a separate water treatment system in addition to that included in the Proposed Action in Section 2.2.2.7. In addition, peak pumpback rates from the North Muleshoe Waste Rock Dump would require the construction of very large passive water treatment cells. Based on this information, a water barrier cover system was carried forward for the North Muleshoe Waste Rock Dump in Alternative 1 in Section 2.2.3.1.3.

Table 2-X Average water quality below waste rock dumps compared to heap leach pad effluent

	Parameters (average concentration mg/L)			
Effluent Source	**Thallium**	**Selenium**	**Arsenic**	**Nitrate/Nitrite**
Heap Leach Pads	***0.807***	***0.121***	***0.241***	***111.9***
Kendall Waste Rock Dump	***0.032***	0.008	0.004	8.1
South Muleshoe Waste Rock Dump	***0.988***	***0.012***	0.014	2.5
North Muleshoe Waste Rock Dump	***0.379***	***0.031***	0.010	***15.1***

Data taken from Table 3-1, Appendix D [CR Kendall needs to update the tables in Appendix D through 2005]

Bold Italicized numbers indicate the concentrations exceed either the human health criteria or chronic aquatic life criteria, whichever standard is more stringent.

Table 2-Y Average pumpback rates from below waste rock dumps compared to heap leach pad effluent

	Pumpback Rate (average gpm)		
Effluent Source	**Average Yearly**	**Peak Monthly**	**Daily Maximum**
Kendall Waste Rock Dump	9.8	35.9	X
South Muleshoe Waste Rock Dump	6.0	18.2	X
North Muleshoe Waste Rock Dump	15.7	48.5	X

Data taken from Tables 3-1 and 3-2, Appendix D [CR Kendall needs to update the tables in Appendix D through 2005]

2.3.8 Reverse Osmosis Water Treatment

RO involves capturing, storing and pumping water at high pressures (up to 1,000 psig) through a membrane system to produce two product water streams: 1) a clean permeate and 2) a concentrated brine. The RO water treatment system would need to be in an enclosed and centrally located facility. CR Kendall has an RO system that was used after operations ceased between 1997 and 1999. This existing RO system, located within the process facility, could be used after closure and possibly expanded if necessary.

The permeate stream has very low concentrations of metals and dissolved solids, while the concentrated brine stream has high concentrations of both dissolved metals and salts. Since RO technology is non-selective, it cannot be used to remove targeted constituents (i.e., selenium, arsenic, thallium and nitrate). Consequently, a relatively large volume of concentrated waste brine (about 25 to 50 percent of the feed water volume) would need to be managed, evaporated, and disposed of at the site, resulting in the relocation of contaminants from one area of the site to another (CITE NEEDED). Disposal of the brine on site is inconsistent with the stated objectives, while off-site brine disposal would represent a very long-term expense.

When used on a long-term basis, RO generally requires pre-treating the water to prevent membrane fouling. Pretreatment at Kendall Mine could include ___________. When fouled, the membranes require cleaning, which is labor intensive and costly since it ultimately destroys the membrane material, resulting in the need for replacement. Membrane replacement would be needed on an _____ basis. [BOB to get this information.]

Comment [KJ19]: possible pretreatment based on Kendall water quality and reason for that pretreatment method

RO was eliminated from further consideration because it generates a large volume of brine that requires disposal, has large water storage and pumping requirements, and does not selectively remove target constituents (CITE NEEDED). RO would generate essentially distilled water, which would be corrosive, desorb metals and dissolve minerals in the drainages to which it was discharged.

Comment [KJ20]: Add to glossary

The treatment plant would need to be centrally located and it would use large quantities of electricity. All contaminated water would need to be pumped to the treatment facility. Treated effluent would require redistribution back to each drainage to meet the desired criteria of returning drainage flows to natural levels. Evaporation of water from the brine would reduce the volume of water available to return to drainages. A centralized RO treatment facility would potentially complicate reclamation efforts since pipelines and plant site infrastructure would need to be maintained and left in place.

While RO could be made effective and is technically implementable, the technology is poorly suited to the proposed application. The need for pretreatment system(s); brine evaporation and disposal; membrane replacement; long-term employment of operators and maintenance staff; and construction, operation, and maintenance of collection and redistribution systems add more expense for water treatment than other equally effective water treatment alternatives.

2.3.9 Ion Exchange Water Treatment

Ion exchange (IX) technology uses synthetic resin media to adsorb pollutants from contaminated water. Since both anions (nitrate, arsenic, and selenium) and cations (thallium) require removal, both anion and cation resin media must be used. IX technology involves capturing water from source areas, pumping it to a storage pond at a centralized location, and routing it through columns packed with IX resin media to remove thallium, arsenic, and selenium until the media is exhausted. When the media becomes exhausted, it would need to be regenerated with chemicals (acids and bases), resulting in a concentrated brine stream, either acidic or highly basic, that would need to be managed. The brine would need to be evaporated on-site and the concentrate would need to be disposed off-site at a licensed disposal facility. Alternatively, a permitted, lined facility would need to be constructed on-site to contain the concentrate.

IX technology was eliminated from further consideration because the media are non-selective for removing target constituents, it generates a large volume of brine requiring evaporation and disposal, and it requires using potentially harmful chemicals (CITE NEEDED). Combining all water sources would result in a need to treat for all parameters, which may otherwise not require treatment in individual drainages. The treatment process does not meet the criteria of restoring natural flows in each drainage without pumping treated water back to each drainage from the treatment facility. Centralized IX water treatment would potentially complicate reclamation efforts since pipelines and plant site infrastructure would need to be maintained and left in place.

While IX technology could be made effective and is technically implementable, it is poorly suited to the proposed application. The need for brine evaporation; concentrate disposal; media replacement; handling and storage of corrosive and caustic chemicals; long-term employment of operators and maintenance staff; and construction, operation, and maintenance of collection and redistribution systems add more expense for water treatment than other equally effective water treatment alternatives.

2.3.10 Chemical Precipitation Water Treatment

Chemical precipitation involves adding iron-bearing solutions, such as ferric chloride or ferrous sulfate, to contaminated water to remove pollutants. When mixed, the iron settles out as a solid along with the pollutants. Chemical precipitation would involve capturing water from source areas, pumping it to a storage pond in a centralized location, and routing it to tanks for mixing with the iron-bearing solutions. Sludge produced from this process would need to be settled in a clarifier and then further dewatered using filter presses prior to disposal off-site at a licensed disposal facility. Alternatively, a permitted, lined facility would need to be constructed on-site to contain the dewatered sludge. The precipitation process does not meet the criteria of restoring natural flows in each drainage without pumping treated water back to each drainage from the treatment facility.

Removing thallium would require pretreatment with hydrogen peroxide to oxidize thallium followed by pH adjustment with caustic or lime (CITE). Following pretreatment, an iron-bearing solution would be added to precipitate thallium, arsenic, and selenium. Achieving water quality standards or MPDES discharge effluent limits is likely not possible using this technology (CITE NEEDED). Nitrate would not be removed by this technology and would require an additional treatment step, such as anaerobic biological treatment, prior to discharge.

Combining all water sources would result in a need to treat for all parameters, which may otherwise not require treatment in individual drainages. Centralized chemical precipitation water treatment would potentially complicate reclamation efforts since pipelines and plant site infrastructure would need to be maintained and left in place.

Chemical precipitation technology to remove thallium, arsenic, selenium, cyanide, and nitrate from CR Kendall mine drainage was eliminated from detailed consideration due to its poor effectiveness for meeting water quality standards; the need to handle large quantities of multiple chemical reagents; sludge disposal; long-term employment of operators and maintenance staff; and construction, operation, and maintenance of collection and redistribution systems add more expense for water treatment than other equally effective water treatment alternatives.

2.3.11 Biological Water Treatment

Biological water treatment could be implemented as either a semi-passive or passive system. A semi-passive biological treatment system would involve installing cells or tanks at a centralized location. The cells or tanks would be filled with bacteria inoculated substrate, and methanol may need to be added to keep the bacteria in the substrate alive and functional. Contaminated water would be collected, stored in a pond, and routed to the treatment tanks prior to redistribution back to the drainages for discharge. Backup cells would be needed to allow for maintenance of cells and replacement of substrate.

The passive method would involve constructing large biotreatment cells filled with bacteria inoculated substrate below the waste rock dumps and the heap leach pads. The cells would need to be sized to handle peak flows. The substrate in the cells would periodically need to be replaced and/or reinoculated.

Beginning in February 1997 CR Kendall tested two pilot-scale passive biological treatment systems within Barnes-King Gulch (E&PC 1999). The more effective system consisted of a lined pond containing 90 percent gravel, 9 percent straw and 1 percent manure. The water to be treated was passed through the cell in a horizontal flow configuration. The water was introduced into the up-gradient end and collected from the down-gradient end of the pond. While the contaminants of concern were treated under relatively low flow conditions and for a short duration, the system is unlikely to perform well under the changing flow conditions at the site (CITE NEEDED). The bacteria within the system that perform the treatment require specific and constant conditions that can easily be upset by changes in flow rate, temperatures, and water chemistry. The pilot system experienced operational problems, such as water channeling through the treatment media, as opposed to uniform flow from one end of the pond to the other as desired.

Without large storage ponds to regulate uneven flow rates, the passive biotreatment cells would need to be designed to handle peak flows, which would require large treatment cells that would not fit into the available land area within the permit boundary below the waste rock dumps or the heap leach pads.

Semi-passive biotreatment systems require long-term employment of operators and maintenance staff; and construction, operation, and maintenance of collection and redistribution systems add more expense for water treatment than other equally effective water treatment alternatives. Combining all water sources would result in a need to treat for all parameters, which may otherwise not require treatment in individual drainages. A centralized biotreatment system would potentially complicate reclamation efforts since pipelines and plant site infrastructure would need to be maintained and left in place. With the exception of nitrate, much of the treatment within the pilot passive biotreatment system was probably not biological in nature, but was simply due to adsorption of the dissolved contaminants to the solid materials in the cell. Given that more efficient adsorption-based systems are available, no advantage can be gained by using biological systems with the possible exception of nitrate treatment (see Section 2.2.3.2.7).

2.3.12 Sustained Primary Water Treatment Using LAD

Land Application Disposal (LAD) involves the irrigation of contaminated waters on vegetated lands. The process removes contaminants by volatilization, uptake by plants, and adsorption in the soil. Water disposed by land application is consumed by evapotranspiration or infiltrates through the soil into groundwater. CR Kendall has an operational LAD system at the mine consisting of a network of plastic pipes and sprinklers that could be adapted for post-closure mine use. A post-closure LAD system would potentially complicate reclamation efforts since pipelines, pump systems and ponds would need to be maintained and left in place.

LAD is commonly used to polish treated water, but is usually not appropriate for primary treatment on a sustained basis (CITE NEEDED-IDAHO DEQ). Plants can only uptake and/or use contaminants during the growing season and the adsorption capacity of the soils is limited. The soils eventually reach a point where they are saturated with metals and other constituents of concern, at which point adsorption stops. Although the volume of soil available for adsorption is large, sustained application of untreated water will eventually become ineffective.

Treated water has much lower concentrations and loads the soils more gradually than does untreated water. In addition, LAD provides more water to native vegetation than is typical for Montana, which tends to change plant community dynamics, stress drought-tolerant native species, kill some native species if contaminant levels are high enough, and favor non-native species (CITE NEEDED-IDAHO DEQ? Or Chapter 4). Plants can also uptake levels of selenium that can be toxic to wildlife and livestock.

Sustained use of LAD can contaminate groundwater if the application rate exceeds plant uptake or soil adsorption capacity. Currently at the Kendall Mine LAD exceeds these rates and infiltrates through the waste rock dumps. This adds to the volume of seepage being pumped back and recirculated to LAD areas. The recirculating water leaches additional contaminants from the waste rock increasing contaminant levels in the waste rock dump seepage. For the above reasons, sustained primary water treatment using LAD for mine water has been eliminated from detailed analysis.

The occasional use of LAD was retained in the proposed alternative and the agency alternatives for handling volumes of water that exceed primary treatment system capacity, for use during treatment system repair and maintenance, or as a polishing step if treated water exceeds discharge standards.

2.3.13 Blending Mine Water for Use by Livestock

Mine water of varying qualities from the different drainages could be blended to produce water appropriate for livestock. Livestock criteria are less stringent than human health standards or aquatic life criteria. The mine waters would have to be pumped to a centralized pond for blending and then redistributed to stock ponds as requested by downstream landowners.

Discharge of mine waters having concentrations in excess of the water quality standards, even for use by livestock, would be in violation of state law. Mine water if used for stock water would have to be contained within a lined pond and not discharge to surface water or groundwater. This would not allow the return of treated mine water to the drainages thus not meeting the primary goal and benefit in Section 1.5.1.2.4.

2.3.14 Water supply wells to supplement water quantity

CR Kendall currently uses water from WW-6 and WW-7 to replace water withdrawn by pumpback systems in South Fork Last Chance Creek and South Fork Little Dog Creek. These wells could be retained and used to continue augmentation of stream flows in these drainages.

Pumping from water supply wells could affect water levels in area springs and wells, although this is unlikely. An aquifer-pumping test was performed in the spring of 2004 to evaluate effects of pumping from WW-6 and WW-7 on area groundwater levels. Due to frequent rain events during the test, water levels in area wells actually increased during pumping (CDM, 2004a).

The use of water supply wells to supplement water quantity was dismissed due to the equal effectiveness and lower costs associated with other techniques. Spring augmentation is a passive method of augmentation and would not require electrical power to and maintenance of pumps. Long-term water treatment of waste rock dump seepage and effluent from the heap leach pads would still be required under any agency alternative prior to discharge. Return of treated water to drainages would minimize the need for augmentation and prevent potential effects to aquifers from pumping.

2.3.15 Removal of on-site and off-site historic tailings

Tailings left on site are buried beneath some waste rock dumps and the mine facilities in the process valley adjacent to the heap leach pads. Removal of on-site tailings would require complete removal of South Muleshoe and Horseshoe Waste Rock Dumps and all material beneath the mine buildings and the upper ponds, Ponds 2A and 2B. The waste rock dumps overlying the tailings are reclaimed.

Wells completed in 2004 within the Kendall and Muleshoe waste rock dumps indicate that the bases of these waste rock dumps are not in contact with the groundwater table (See Appendix A for the well locations and completion logs) (CDM 2004a). DEQ inspected well TMW-15B located in the Little Dog Creek drainage below the Horseshoe Waste Rock Dump and determined the water table was well below the base of the tailings deposit. The project objective of limiting groundwater and mine waste interactions could be met without relocating the tailings and waste rock to the pits.

Accessible off-site tailings are located in Little Dog Creek and Barnes-King Gulch (Figure 2-XX). CR Kendall must agree to the removal of and possible use of off-site tailings for reclamation purposes as allowed under MEPA (GET CITATION). CR Kendall must obtain landowner consent to remove any off-site tailings. The disturbance created by removing off-site historic tailings would be regraded, ripped, and revegetated using an agency and landowner approved seed mix.

The removal of on-site tailings is dismissed from further consideration as it does not meet any identified primary goal or benefit in Section 1.5.2.1 except it would prevent the contact of waste rock dump seepage with historic tailings and reduce the amount of contamination reaching groundwater. There are more effective and less costly methods to reduce infiltration into the waste rock dumps and into the groundwater beneath the dumps. These methods include installing barrier covers as discussed above in Section 2.3.7, improving reclamation cover systems and revegetation success, and improving drainage systems to reduce storm water runon and directing runoff.

2.3.16 Summary of Alternative Components Dismissed

Table 2-2 provides a summary of the reasons for dismissing each of the 15 alternative components described above.

Table 2-2
Summary of Alternative Components Dismissed from Further Evaluation and the Associated Reason(s)

Alternative Component	Effectiveness*	Adverse Impacts	Implementability	Consequences of Failure	Reliability	Reasonableness	Cost
Waste rock dump and tailings removal to the pits	X				X	X	X
Complete pit backfill with liners and leachate collection	X	X	X	X			
Leach pad removal	X	X	X	X			
GCL covers for heap leach pads, waste rock dumps and/or backfilled pits							
Composite reclamation covers for leach pads, waste rock dumps and/or backfilled pits							X
Combination of reclamation cover systems for leach pads, waste rock dumps and/or backfilled pits	X						
Barrier cover systems for waste rock dumps and/or backfilled pits.							
Reverse osmosis water treatment							X
Ion exchange water treatment							X
Chemical precipitation water treatment	X						
Biological water treatment	X		X	X	X		
Sustained primary water treatment using LAD							
Blending mine water for use by livestock	X						
Water supply wells to supplement water quantity							X
Removal of on-site and off-site historic tailings			X				

*Effectiveness refers to the ability of the component to meet the project goals, as outlined in Section 1.5

2.4 Reasonably Foreseeable Activities

Reasonably foreseeable activities include those activities that have either been permitted or for which planning documents have been prepared. The Fergus County Commission was contacted in regard to any future plans, such as road building in the area. Currently, the county has no plans in the area. The BLM has plans to provide a public access road across the mining claims from the mine gate to BLM properties. A second access road extending from the mine shops to the Abbey claim group in Dog Creek is also planned. The BLM has also approved a timber sale above the mine site (west of the permit boundary).

Summary of Alternatives and Comparison with Respect to Project Objectives

A summary of the alternatives is shown in Table 2-10 below. Additional comparison of alternatives will be presented in Chapter 5, once the Affected Environment (Chapter 3) and Impacts and Mitigations (Chapter 4) have been evaluated.

Table 2-10
Summary of Alternatives

Component	Proposed Alternative	Alternative 1	Alternative 2	No Action Alternative
Leach Pad Capping	Single membrane liner	Single membrane liner	36-inch water balance	56-inch RPL
Waste Rock Capping	36-inch water balance cap above drain layer	Single membrane liner	36-inch water balance cap above drain layer	56-inch RPL
Disturbed Area Soil Cover	12 inches of soil	12 inches of soil	12 inches of soil	8-14 inches of soil
Pit Backfill	Partial	Partial	Partial	Partial
Kendall Dump Regrade	All slopes to ≤ 3:1 (~1 million CY regraded)	All slopes to ≤ 3:1 (~1 million CY regraded)	All slopes to ≤ 3:1 (~1 million CY regraded)	Partial regrade of slopes >3:1 (21,000 CY regraded)
Water Treatment	Passive adsorption-based technology with LAD contingency	Passive adsorption-based technology with LAD contingency	Passive adsorption-based technology with LAD contingency	Adsorption-based technology for KVPB-5 and TMW-26. LAD for heap-leach, KVPB-2 and KVPB-6
Ditches	Bentonite amendment when over waste rock	Bentonite amendment when over waste rock	Bentonite amendment when over waste rock	Step pools with local clay amendment
Historical Tailings	Place accessible off-site tailings on the leach pads	Place accessible off-site tailings on the leach pads	Place accessible off-site tailings on the leach pads	An off-site repository would be constructed at a later date
Infrastructure	Leave in place	Leave in place	Leave in place	Leave in place
Plume Control	Passive groundwater collection	Passive groundwater collection	Passive groundwater collection	Active pumping of pump-back wells
Water Augmentation	Treated groundwater ± augmentation with spring water	Treated groundwater ± augmentation with spring water	Treated groundwater ± augmentation with spring water	Active pumping from wells WW-6 and WW-7

A comparison of the alternatives in terms of how well they meet the reclamation goals are presented in Table 2-11.

Table 2-11
Summary of Effectiveness for Each Alternative

Goal	Proposed Action	Alternative 1	Alternative 2	No Action Alternative
Effectiveness: Primary Goals				

Table 2-11
Summary of Effectiveness for Each Alternative

Goal	Proposed Action	Alternative 1	Alternative 2	No Action Alternative
Improve revegetation of the mine site	**Moderate:** Characterization of all reclamation materials; limited regrading and slope reduction of north face of Kendall Waste Rock Dump; 6 inches of soil added where revegetation is inadequate; modified seed mixes; LAD use for contingency use only;	**Moderate:** Same as Proposed Action except 20 inches soil on North Muleshoe Waste Rock Dump	**Moderate:** Same as Proposed Action except no additional backfill to Kendall Pit; no regrading of Kendall Waste Rock Dump; partial backfill of Muleshoe Pit with removal of North Muleshoe Waste Rock Dump; 8 to 10 inches of soil on backfilled Muleshoe Pit and 8inches of soil where needed in North Muleshoe Waste Rock Dump footprint	**Low:** Approved 1995 Reclamation Plan does not identify steps to address limited revegetation success on some areas of the mine.
Limit contact between mine wastes and high quality surface water	**Moderate:** Improvements to stormwater conveyances; characterization of soils and borrow materials;	**Moderate:** Same as Proposed Action	**Moderate/High:** Same as Proposed Action, except North Muleshoe Waste Rock Dump removed and footprint reclaimed.	**Low:** Reclamation cover materials and ditch lining materials were inadequately characterized and may be contaminated;
Limit contact between mine wastes and high quality groundwater	**High:** Same as No Action	**High:** Same as No Action	**High:** Same as No Action	**High:** Mine wastes have not been found to be in contact with groundwater

Limit low quality mine waste seepage into groundwater	**Moderate:** Existing reclamation covers would be the same as No Action except all new reclamation would use characterized reclamation materials; an additional 6 inches of soil would be placed on the waste rock dumps where revegetation is inadequate or LAD contaminated soils; a barrier reclamation cover system would be installed on the heap leach pads; portions of stormwater channels would be reconstructed to minimize infiltration; step pools would be removed once vegetation is established	**Moderate / High:** Same as Proposed Action except North Muleshoe Waste Rock Dump would be capped with a barrier reclamation cover system.	**Moderate / Low:** Same as Proposed Action except the heap leach pads would be capped with 36-inch soil cover system; no barrier reclamation cover systems used; North Muleshoe Waste Rock Dump would be removed and backfilled into the Muleshoe Pit;	**Low:** All reclamation covers would be or have been constructed with potentially contaminated materials; LAD may have contaminated some reclaimed areas and increased infiltration through mine wastes; none of the covers prevent infiltration into mine wastes; some storm water channels and step pools were lined with potentially contaminated materials and allow infiltration into mine wastes;
Limit transport of fine-grained or contaminated sediments	**Moderate:** Same as No Action except step pools would reclaimed when vegetation is adequate; revegetation success improved as described above;	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action	**Moderate/Low:** Step pools in rip rapped stormwater channels; sediment ponds at base of waste rock dumps; site revegetation
Meet Montana surface water and groundwater quality standards for mine waters leaving the site	**Moderate:** LAD only used as a contingency; a passive adsorption water treatment system would be used in each	**Moderate/High:** Same as Proposed Action, except that theNorth Muleshoe Waste Rock Dump would be covered with a	**Low/ Moderate:** Same as Proposed Action, except the heap leach pads would be reclaimed using a 36-inch soil	**Low:** LAD and treating pump-back water with zeolites at the process plant; RO approved but not being used.

	drainage; short-term passive biological water treatment system for nitrates would be installed for nitrates in Little Dog Creek; barrier reclamation cover system on heap leach pads would minimize effluent.	barrier cover to minimize contaminated seepage in the South Little Dog Creek watershed	cover system and would require an additional passive biological water treatment system for nitrate in the heap leach pad effluent. The North Muleshoe Waste Rock Dump would be removed from the South Little Dog Creek drainage.	
Restore water quantity in each drainage to pre-modern mining levels	**High:** Passively treating and discharging seepage in each drainage; augmenting flow in the South Fork of Last Chance Creek and in Little Dog Creek with diverted spring water; and improving the lining of stormwater ditches will increase flows in all drainages	**High:** Same as Proposed Action, except barrier cover on the North Muleshoe Waste Rock Dump would increase stormwater runoff volume.	**High:** Same as Proposed Action, except the North Muleshoe Waste Rock Dump would be removed and used as backfill in the Muleshoe Pit. This would increase the acreage from which stormwater runoff could occur.	**Moderate / High:** Augmentation from pumping wells WW-6 and WW-7, and diversion from Upper Little Dog Spring to Section 29 Spring; Mason Canyon Spring diversion to the South Fork Last Chance Creek is pending approval from the BLM. Unlined ditches route stormwater offsite, but also lose water into mine wastes.
Limit public access to sensitive or potentially dangerous areas of the site.	**Moderate/high:** Same as No Action, except the public access road would be moved back from the edges of the Barnes-King and Kendall pits, and all lined ponds retained for use for long term water management would be fenced to prevent access.	**Moderate/High:** Same as Proposed Action	**Moderate/High:** Same as Proposed Action	**Moderate/High:** Except for public access roads, the site will remain fenced and locked to discourage unauthorized access to the pits. All ponds would be reclaimed.

Table 2-11 *(Continued)*
Summary of Effectiveness for Each Alternative

Goal	Proposed Alternative	Alternative 1	Alternative 2	No Action Alternative
Effectiveness: Secondary Goals				
Improve the aesthetics of the site	**Moderate:** Resloping of the Kendall Waste Rock Dump's north slope will result in the revegetation of some additional acreage within the Kendall Pit. Revegetation would be enhanced by adding additional soil where the vegetative cover is inadequate.	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action, except that the North Muleshoe Waste Rock Dump would be removed and used as backfill in the Muleshoe Pit. This would restore the dump footprint to pre-mining topography and cover a portion of the highwall in the Muleshoe Pit.	**Moderate:** No additional backfilling would be performed; revegetation of all disturbances except inaccessible pit highwalls would be completed.
Remove off-site historic tailings	**Moderate:** If agreed to by CR Kendall and affected landowners, historic tailings would be removed from Barnes-King Gulch and Little Dog Creek	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action	**Low:** No additional tailings would be removed from off-site locations in the channels of Little Dog Creek or Barnes-King Gulch.
Other Screening Criteria				
Adverse Impacts	**Moderate/Low:** Revegetation would still be inadequate on some acres. LAD used as a contingency could potentially impact soils or vegetation in some areas.	**Moderate/Low:** Same as Proposed Action	**Moderate/Low:** Same as Proposed Action, except placing additional waste rock as backfill into the Muleshoe Pit could increase contaminant loading to the Madison Aquifer.	**High:** Water Quality Standards would not be met; Large volume of effluent from the reclaimed heap leach pads. Revegetation would be inadequate on some areas; LAD would continue to impact soils and vegetation. Continued augmentation of surface water from

				pumping WW-6 and WW-7 could deplete groundwater resources.

Implementability	**High:** Same as No Action	**High:** Same as No Action	**High:** Same as No Action	**High:** All reclamation and water treatment can be performed using existing technology
Reliability Likelihood and duration that technology will continue to function as intended in the future if maintained.	**Moderate/High:** Reclamation materials would be characterized to limit contaminants in heap leach pad and mine facilities area, resoiled areas on waste rock dumps and pits and reconstructed stormwater channels; barrier reclamation cover system would continue to operate properly as long as the liner remains buried and not torn, ripped, or damaged by slumping material, tree roots, burrowing animals, etc.; passive adsorption based treatment systems would continue to function as long as media is replaced as needed; LAD would be used as a contingency on limited acres; liners in ponds left for water management have a limited lifespan	**Moderate/High:** Same as Proposed Action except barrier cover would also be used on the North Muleshoe Waste Rock Dump with the same reliability issues as the heap leach pads under the Proposed Action.	**Moderate/High:** Same as Proposed Action except more treatment systems are needed for heap leach effluent for nitrates, cyanide, and arsenic; smaller treatment system needed below the North Muleshoe Waste Rock Dump footprint;	**Low:** All reclamation materials would likely continue to produce contaminated leachate; RPL caps would continue to allow infiltration; impacts to soils and vegetation.from LAD would get worse over time;

Consequences of Failure	**Moderate:** Vegetation inadequacy would be limited; LAD would only be used as a contingency; if barrier reclamation cover system on heap leach pads failed, pumpback and LAD would be used to limit discharge until repairs could be made or a more complex water treatment system for nitrates, cyanide, and arsenic could be installed if the cover system could not be replaced; leaking pond liners would allow contaminated water to seep into groundwater—pond would have to be drained and water land applied or stored in other pond(s) until liner repaired; failure of any water treatment system below waste rock dumps would require implementation of pumpback and LAD until the water treatment system could be repaired.	**Moderate:** Same as Proposed Action except potential for failure of barrier reclamation cover systems in two drainages with similar consequences and contingencies	**Moderate:** No barrier reclamation cover system to fail. If the water treatment system failed below the heap leach pads, then pumpback and LAD would be used until the water treatment system could be repaired.	**High:** Vegetation is inadequate in some areas because of contaminants in reclamation materials and from LAD; Cover systems have already failed to limit infiltration; pumpback systems do not capture all contaminated water; no contingency to cover pumpback system failure;

Reasonableness***tinued)***

~~**Summary of Effectiveness for Each Alternative**~~

Cost

Goal	Proposed Alternative	Alternative 1	Alternative 2	No Action Alternative
Effectiveness: Secondary Goals				
Improve the aesthetics of the site	**Moderate:** Resloping of the Kendall Waste Rock Dump's north slope will result in the revegetation of some additional acreage within the Kendall Pit. Revegetation would be enhanced by adding additional soil where the vegetative cover is inadequate.	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action, except that the North Muleshoe Waste Rock Dump would be removed and used as backfill in the Muleshoe Pit. This would restore the dump footprint to pre-mining topography and cover a portion of the highwall in the Muleshoe Pit.	**Moderate:** No additional backfilling would be performed; revegetation of all disturbances except inaccessible pit highwalls would be completed.
Remove off-site historic tailings	**Moderate:** If agreed to by CR Kendall and affected landowners, historic tailings would be removed from Barnes-King Gulch and Little Dog Creek	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action	**Low:** No additional tailings would be removed from off-site locations in the channels of Little Dog Creek or Barnes-King Gulch.
Other Screening Criteria				
Adverse Impacts	**Moderate/Low:** Revegetation would still be inadequate on some acres. LAD used as a contingency could potentially impact soils or vegetation in some areas.	**Moderate/Low:** Same as Proposed Action	**Moderate/Low:** Same as Proposed Action, except placing additional waste rock as backfill into the Muleshoe Pit could increase contaminant loading to the Madison Aquifer.	**High:** Water Quality Standards would not be met; Large volume of effluent from the reclaimed heap leach pads. Revegetation would be inadequate on some areas; LAD would continue to impact soils and vegetation. Continued

				augmentation of surface water from pumping WW-6 and WW-7 could deplete groundwater resources.

Implementability	**High:** Same as No Action	**High:** Same as No Action	**High:** Same as No Action	**High:** All reclamation and water treatment can be performed using existing technology
Reliability Likelihood and duration that technology will continue to function as intended in the future if maintained.	**Moderate/High:** Reclamation materials would be characterized to limit contaminants in heap leach pad and mine facilities area, resoiled areas on waste rock dumps and pits and reconstructed stormwater channels; barrier reclamation cover system would continue to operate properly as long as the liner remains buried and not torn, ripped, or damaged by slumping material, tree roots, burrowing animals, etc.; passive adsorption based treatment systems would continue to function as long as media is replaced as needed; LAD would be used as a contingency on limited acres; liners in ponds left for water management have a limited lifespan	**Moderate/High:** Same as Proposed Action except barrier cover would also be used on the North Muleshoe Waste Rock Dump with the same reliability issues as the heap leach pads under the Proposed Action.	**Moderate/High:** Same as Proposed Action except more treatment systems are needed for heap leach effluent for nitrates, cyanide, and arsenic; smaller treatment system needed below the North Muleshoe Waste Rock Dump footprint;	**Low:** All reclamation materials would likely continue to produce contaminated leachate; RPL caps would continue to allow infiltration; impacts to soils and vegetation.from LAD would get worse over time;

Consequences of Failure	**Moderate:** Vegetation inadequacy would be limited; LAD would only be used as a contingency; if barrier reclamation cover system on heap leach pads failed, pumpback and LAD would be used to limit discharge until repairs could be made or a more complex water treatment system for nitrates, cyanide, and arsenic could be installed if the cover system could not be replaced; leaking pond liners would allow contaminated water to seep into groundwater—pond would have to be drained and water land applied or stored in other pond(s) until liner repaired; failure of any water treatment system below waste rock dumps would require implementation of pumpback and LAD until the water treatment system could be repaired.	**Moderate:** Same as Proposed Action except potential for failure of barrier reclamation cover systems in two drainages with similar consequences and contingencies	**Moderate:** No barrier reclamation cover system to fail. If the water treatment system failed below the heap leach pads, then pumpback and LAD would be used until the water treatment system could be repaired.	**High:** Vegetation is inadequate in some areas because of contaminants in reclamation materials and from LAD; Cover systems have already failed to limit infiltration; pumpback systems do not capture all contaminated water; no contingency to cover pumpback system failure;

Reasonableness***tinued)***

Summary of Effectiveness for Each Alternative

Cost

Goal	Proposed Alternative	Alternative 1	Alternative 2	No Action Alternative
Effectiveness: Secondary Goals				
Improve the aesthetics of the site	**Moderate:** Resloping of the Kendall Waste Rock Dump's north slope will result in the revegetation of some additional acreage within the Kendall Pit. Revegetation would be enhanced by adding additional soil where the vegetative cover is inadequate.	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action, except that the North Muleshoe Waste Rock Dump would be removed and used as backfill in the Muleshoe Pit. This would restore the dump footprint to pre-mining topography and cover a portion of the highwall in the Muleshoe Pit.	**Moderate:** No additional backfilling would be performed; revegetation of all disturbances except inaccessible pit highwalls would be completed.
Remove off-site historic tailings	**Moderate:** If agreed to by CR Kendall and affected landowners, historic tailings would be removed from Barnes-King Gulch and Little Dog Creek	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action	**Low:** No additional tailings would be removed from off-site locations in the channels of Little Dog Creek or Barnes-King Gulch.
Other Screening Criteria				
Adverse Impacts	**Moderate/Low:** Revegetation would still be inadequate on some acres. LAD used as a contingency could potentially impact soils or vegetation in some areas.	**Moderate/Low:** Same as Proposed Action	**Moderate/Low:** Same as Proposed Action, except placing additional waste rock as backfill into the Muleshoe Pit could increase contaminant loading to the Madison Aquifer.	**High:** Water Quality Standards would not be met; Large volume of effluent from the reclaimed heap leach pads. Revegetation would be inadequate on some areas; LAD would continue to impact soils and vegetation. Continued

				augmentation of surface water from pumping WW-6 and WW-7 could deplete groundwater resources.

Implementability	**High:** Same as No Action	**High:** Same as No Action	**High:** Same as No Action	**High:** All reclamation and water treatment can be performed using existing technology
Reliability Likelihood and duration that technology will continue to function as intended in the future if maintained.	**Moderate/High:** Reclamation materials would be characterized to limit contaminants in heap leach pad and mine facilities area, resoiled areas on waste rock dumps and pits and reconstructed stormwater channels; barrier reclamation cover system would continue to operate properly as long as the liner remains buried and not torn, ripped, or damaged by slumping material, tree roots, burrowing animals, etc.; passive adsorption based treatment systems would continue to function as long as media is replaced as needed; LAD would be used as a contingency on limited acres; liners in ponds left for water management have a limited lifespan	**Moderate/High:** Same as Proposed Action except barrier cover would also be used on the North Muleshoe Waste Rock Dump with the same reliability issues as the heap leach pads under the Proposed Action.	**Moderate/High:** Same as Proposed Action except more treatment systems are needed for heap leach effluent for nitrates, cyanide, and arsenic; smaller treatment system needed below the North Muleshoe Waste Rock Dump footprint;	**Low:** All reclamation materials would likely continue to produce contaminated leachate; RPL caps would continue to allow infiltration; impacts to soils and vegetation.from LAD would get worse over time;

Consequences of Failure	**Moderate:** Vegetation inadequacy would be limited; LAD would only be used as a contingency; if barrier reclamation cover system on heap leach pads failed, pumpback and LAD would be used to limit discharge until repairs could be made or a more complex water treatment system for nitrates, cyanide, and arsenic could be installed if the cover system could not be replaced; leaking pond liners would allow contaminated water to seep into groundwater—pond would have to be drained and water land applied or stored in other pond(s) until liner repaired; failure of any water treatment system below waste rock dumps would require implementation of pumpback and LAD until the water treatment system could be repaired.	**Moderate:** Same as Proposed Action except potential for failure of barrier reclamation cover systems in two drainages with similar consequences and contingencies	**Moderate:** No barrier reclamation cover system to fail. If the water treatment system failed below the heap leach pads, then pumpback and LAD would be used until the water treatment system could be repaired.	**High:** Vegetation is inadequate in some areas because of contaminants in reclamation materials and from LAD; Cover systems have already failed to limit infiltration; pumpback systems do not capture all contaminated water; no contingency to cover pumpback system failure;

Table 2-11 (Continued)
Summary of Effectiveness for Each Alternative

Reasonableness				
Cost				
Goal	**Proposed Alternative**	**Alternative 1**	**Alternative 2**	**No Action Alternative**
Effectiveness: Secondary Goals				
Improve the aesthetics of the site	**Moderate:** Resloping of the Kendall Waste Rock Dump's north slope will result in the revegetation of some additional acreage within the Kendall Pit. Revegetation would be enhanced by adding additional soil where the vegetative cover is inadequate.	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action, except that the North Muleshoe Waste Rock Dump would be removed and used as backfill in the Muleshoe Pit. This would restore the dump footprint to pre-mining topography and cover a portion of the highwall in the Muleshoe Pit.	**Moderate:** No additional backfilling would be performed; revegetation of all disturbances except inaccessible pit highwalls would be completed.
Remove off-site historic tailings	**Moderate:** If agreed to by CR Kendall and affected landowners, historic tailings would be removed from Barnes-King Gulch and Little Dog Creek	**Moderate:** Same as Proposed Action	**Moderate:** Same as Proposed Action	**Low:** No additional tailings would be removed from off-site locations in the channels of Little Dog Creek or Barnes-King Gulch.
Other Screening Criteria				
Adverse Impacts	**Moderate/Low:** Revegetation would still be inadequate on some acres. LAD used as a contingency could potentially impact soils or vegetation in some areas.	**Moderate/Low:** Same as Proposed Action	**Moderate/Low:** Same as Proposed Action, except placing additional waste rock as backfill into the Muleshoe Pit could increase contaminant loading to the Madison Aquifer.	**High:** Water Quality Standards would not be met; Large volume of effluent from the reclaimed heap leach pads. Revegetation would be inadequate on some areas; LAD would continue to impact soils and vegetation. Continued augmentation of surface water from pumping WW-6

				and WW-7 could deplete groundwater resources.

Implementability	**High:** Same as No Action	**High:** Same as No Action	**High:** Same as No Action	**High:** All reclamation and water treatment can be performed using existing technology
Reliability Likelihood and duration that technology will continue to function as intended in the future if maintained.	**Moderate/High:** Reclamation materials would be characterized to limit contaminants in heap leach pad and mine facilities area, resoiled areas on waste rock dumps and pits and reconstructed stormwater channels; barrier reclamation cover system would continue to operate properly as long as the liner remains buried and not torn, ripped, or damaged by slumping material, tree roots, burrowing animals, etc.; passive adsorption based treatment systems would continue to function as long as media is replaced as needed; LAD would be used as a contingency on limited acres; liners in ponds left for water management have a limited lifespan	**Moderate/High:** Same as Proposed Action except barrier cover would also be used on the North Muleshoe Waste Rock Dump with the same reliability issues as the heap leach pads under the Proposed Action.	**Moderate/High:** Same as Proposed Action except more treatment systems are needed for heap leach effluent for nitrates, cyanide, and arsenic; smaller treatment system needed below the North Muleshoe Waste Rock Dump footprint;	**Low:** All reclamation materials would likely continue to produce contaminated leachate; RPL caps would continue to allow infiltration; impacts to soils and vegetation.from LAD would get worse over time;

Consequences of Failure	**Moderate:** Vegetation inadequacy would be limited; LAD would only be used as a contingency; if barrier reclamation cover system on heap leach pads failed, pumpback and LAD would be used to limit discharge until repairs could be made or a more complex water treatment system for nitrates, cyanide, and arsenic could be installed if the cover system could not be replaced; leaking pond liners would allow contaminated water to seep into groundwater—pond would have to be drained and water land applied or stored in other pond(s) until liner repaired; failure of any water treatment system below waste rock dumps would require implementation of pumpback and LAD until the water treatment system could be repaired.	**Moderate:** Same as Proposed Action except potential for failure of barrier reclamation cover systems in two drainages with similar consequences and contingencies	**Moderate:** No barrier reclamation cover system to fail. If the water treatment system failed below the heap leach pads, then pumpback and LAD would be used until the water treatment system could be repaired.	**High:** Vegetation is inadequate in some areas because of contaminants in reclamation materials and from LAD; Cover systems have already failed to limit infiltration; pumpback systems do not capture all contaminated water; no contingency to cover pumpback system failure;

Reasonableness				
Cost				

Chapter 3
Affected Environment

Chapter 3 presents descriptions of the affected environment or resources in the project vicinity. The primary source of information for much of the Affected Environment section will be the 1989 Environmental Assessment prepared by GCM Services and the 2001 Checklist EA prepared by DEQ.

3.1 Location Description

The Kendall Mine is located in central Fergus County approximately 7 miles west of Hilger, Montana on the eastern slope of the North Moccasin Mountains (see Figure 1-1). The CR Kendall permit boundary is located in Sections 29, 30, 31, and 32 of Township 18 North, Range 18 East and Section 6 of Township 17 North, Range 18 East.

The terrain is characterized by narrow valleys and steep rugged slopes. The permit boundary encompasses much of the headwaters of Last Chance and Little Dog Creeks. Elevations range from 4,400 feet on the valley floor to 5,480 feet on the mountain slopes.

3.2 Land Use

The 1989 EA states that the primary historical land use of the disturbed areas was mining. In addition, recreational use (including hunting and day use) and other uses such as wildlife habitat and livestock grazing were also considered pre-operation land uses.

During mining operations, public access to the area is denied. Public access to the North Moccasin Mountains through the permit area will be provided after mine closure and reclamation. Access will be controlled by fencing.

Post-operation land use objectives for the mine site include:

- Protection of public health and safety by removal of hazards
- Re-establishment of wildlife habitat and livestock grazing
- Protection of water quality through reduction of erosion and sedimentation
- Enhancement of aesthetics (restoration of rock dump faces and pit benches)

3.3 Geology and Soil Resources

3.3.1 Geology

Gold mineralization in the North Moccasin Mining District is directly related to the intrusion of igneous rocks and associated hydrothermal activity. During and after upwelling and emplacement of the syenite porphyry, hydrothermal groundwater flow was directed along existing zones of structural weakness at the top of the Madison Formation. Hot and likely low pH waters carried dissolved gold and other metals that were deposited in a brecciated zone of

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Deleted: C:\Documents and Settings\CB8506\My Documents\EIS\Kendall\Chapter_3_2-3-06.doc altered syenite and Madison Limestone. These deposits constituted the major gold accumulation that was exploited by underground and open pit mining and cyanide processing.

Gold mineralization remains on the CR Kendall Mine site, which has not yet been mined and could represent future resources. Other unexploited metal mineralization has also been identified in breccia pipes intruded into syenite porphyry. One such pipe is exposed in the Plum Creek Drainage in the central portion of the North Moccasin Mountains approximately 1.5 miles northwest of the Kendall Mine.

3.3.2 Soil Resources

Reclamation resources include stockpiled soil and stockpiled or in-place geologic material to be used to construct reclamation covers for reclaimed areas of the mine site (CITE Exhibit 2 from 2005 Annual report FIGURE showing stockpile locations). Shafer and Associates (1995) prepared a revegetation plan and identified available reclamation resources within the mine permit boundary. A portion of those resources has been used in reclamation activities at the mine.

The 2005 annual report states that approximately 221,667 cubic yards (CY) of reclamation resources were stockpiled or identified on the site (CR Kendall 2006). A 2004 field evaluation provided an estimate of 146,750 CY (DEQ 2005). Addition of the reclamation resources identified by CR Kendall in the summer of 2004, while recontouring the process valley, brings the total to 212,750 CY (Table 3-1). The reclamation resources were rated for quality as follows:

Good (Grade 1) – These materials consist primarily of soil. These soil materials have the lowest volume of coarse fragments compared to other reclamation resources. The organic matter content likely exceeds two percent and has a darker color than the other reclamation resources. Textures for these materials range from loam (mixture of sand, silt, and clay in approximately equal proportions) to clay. Removal of the coarse fragments greater than three inches in diameter from the good quality soil materials would be beneficial for long-term site productivity and plant health. The

Table 3-1

good quality soils should be preferentially used for areas with gentle slopes, less than 10 percent, designated to support the more productive plant communities.

Fair (Grade 2) – These reclamation resources are a mixture of soil and geologic materials The coarse fragment content is greater than for the good reclamation resources and may limit site productivity. These materials contain rocks and boulders that exceed 12 inches in diameter and may contain some woody materials (logs, posts, limbs). The organic matter content is generally less than two percent. Because of the rock content there is a reduced water holding capacity and cation exchange capacity. Textures range from coarse sandy loam through sandy clay loam with occasional clay.

Poor (Grade 3) – These reclamation materials are primarily geologic materials from the upper unconsolidated bedrock. These materials have little or no water holding capacity or cation exchange capacity. The coarse fragment content is high and will limit site productivity. Textures are coarser than the fair or good reclamation materials. Poor grade reclamation resources would be used on slopes, where the coarser material would limit erosion.

An additional 6,300 CY of stockpiled waste rock material are available for other uses such as drain layer and rip-rap (CR Kendall 2006).

Samples were collected in July 2003 to evaluate the leachability of metals in the reclamation resource stockpiles (CDM 2004c). Samples were analyzed using the synthetic precipitation and leaching procedure (SPLP) (EPA Method 1312). Results indicated that antimony, arsenic, and/or thallium are leachable at levels above water quality criteria from all six of the 2003 samples (Table 3-2). Selenium was detected in five of the six 2003 samples, but at levels well below the human health water quality criteria level of 0.050 milligrams per liter (mg/L).

In 2004, CR Kendall recontoured the process valley and constructed ditches in natural geologic materials adjacent to the leach pads. CR Kendall sampled the materials to determine suitability for reclamation (see Table 3-2 and Appendix F, samples SB-1 through SB-5) (Womack & Associates, Inc. 2005). The sampling indicated the materials have lower metals leachability than the stockpiles sampled in 2003, with the exception of two samples containing antimony at levels above water quality criteria.

DEQ field checked CR Kendall's proposed reclamation resource material. These field investigations revealed that the natural geologic layers where sample SB-2 was collected contain abundant black shale and are acid producing. A seep originating near SB-2 had a pH of 3 (a pH of 7 is neutral). This indicates that the undisturbed black shales are generating natural acid rock drainage. These materials will not be used for reclamation.

Sample site SB-1 is located on the northern edge of leach pad 3 and at the base of a steep slope. If these materials were used for reclamation, the slope would be increased and would be difficult to reclaim. As a result, materials from the SB-1 sample area are not being considered for reclamation.

In the summer of 2004, material was removed during ditch construction on the southwest side of the process valley. Some material was used for reclaiming portions of the swale between leach pads 3 and 4. An additional 10,000 CY was stockpiled. Ditch construction undercut the toe of a pre-existing slump which destabilized the hillside and may result in more slumping. The slump area is shown on Figure 1-2 as an area of bare ground to the west of leach pad 4. [LABEL THIS AREA ON NEW FIGURE 1-2]

Table 3-2
Reclamation Resource Analytical Results
CR Kendall Mine Fergus County, Montana

			SPLP Extractable Constituents (mg/L)				
Stockpile	**Sample Depth (ft bgs)**	**Sample No.**	**Antimony**	**Arsenic**	**Selenium**	**Thallium**	**Mixing Ratio**
MT Water Quality Human Health Standard			**0.006**	**0.018**	**0.050**	**0.002**	
2003 Samples							
A-7	0-3	CRK-SSA7-1	<0.003	**0.058**	<0.001	<0.001	20:1
TS-2a	0-3	CRK-TS2A-1	<0.003	**0.021**	0.002	0.001	20:1
C-1	0-3	CRK-SSC1-1	0.006	**0.078**	0.002	**0.017**	20:1
A-1	0-3	CRK-SSA1-1	<0.003	0.006	0.001	<0.001	20:1
B-5	0-3	CRK-DRB5-1	0.005	**0.019**	0.003	<0.001	2:1
B-5	0-3	CRK-DRB5-1	**0.006**	**0.048**	0.004	0.007	5:1
B-5	0-3	CRK-DRB5-1	<0.003	**0.026**	0.002	**0.002**	10:1
TS-6	0-3	CRK-TS6-1	**0.016**	**0.055**	0.002	**0.014**	20:1
2004 Samples							
SB-1	unknown	CR Kendall SB-1,SPLP 2:1	<0.003	<0.003	<0.001	<0.002	2:1
SB-1	unknown	CR Kendall SB-1, SPLP 5:1	<0.003	0.016	<0.001	<0.002	5:1
SB-1	unknown	CR Kendall SB-1, SPLP 10:1	<0.003	0.012	<0.001	<0.002	10:1
SB-2	unknown	CR Kendall SB-2, SPLP 2:1	**0.008**	0.006	0.002	<0.002	2:1
SB-2	unknown	CR Kendall SB-2, SPLP 5:1	<0.003	<0.003	0.001	<0.002	5:1
SB-2	unknown	CR Kendall SB-2, SPLP 10:1	<0.003	0.005	<0.001	<0.002	10:1
SB-3	unknown	CR Kendall SB-3, SPLP 2:1	0.003	<0.003	0.001	<0.002	2:1
SB-3	unknown	CR Kendall SB-3, SPLP 5:1	**0.006**	0.004	0.001	<0.002	5:1
SB-3	unknown	CR Kendall SB-3, SPLP 10:1	<0.003	<0.003	0.001	<0.002	10:1
SB-4	unknown	CR Kendall SB-4, SPLP 2:1	<0.003	<0.003	<0.001	<0.002	2:1
SB-4	unknown	CR Kendall SB-4, SPLP 5:1	<0.003	<0.003	<0.001	<0.002	5:1
SB-4	unknown	CR Kendall SB-4, SPLP 10:1	<0.003	0.003	<0.001	<0.002	10:1
SB-5	unknown	CR Kendall SB-5, SPLP 2:1	<0.003	<0.003	<0.001	<0.002	2:1
SB-5	unknown	CR Kendall SB-5, SPLP 5:1	<0.003	<0.003	<0.001	<0.002	5:1
SB-5	unknown	CR Kendall SB-5, SPLP 10:1	<0.003	<0.003	<0.001	<0.002	10:1

Notes: **Bold** values indicate exceedance of Montana WQB-7 water quality standards for human health
ft bgs = feet below ground surface
mg/L = milligram per liter

Comment [HS21]: Change – Name is now DEQ-7

3.4 Water Resources

The following sections present a summary of the subsurface and surface hydrology and water resources at the CR Kendall Mine. The majority of this information was derived from the review of previous studies. The principal sources of information are:

- Water Management Consultants, Inc. 1999. "Evaluation of Background Hydrochemistry for the Kendall Mine". Prepared for Canyon Resources Corp., Golden, Colorado. January.
- Water Management Consultants, Inc. 2003. "Evaluation of Recent Monitoring Data and Updated Assessment of Background Chemistry". Prepared for Kendall Mine. Hilger, MT. December.
- Gallagher, K. 2002. "Flowpath Evaluation for the CR Kendall Mine Area, Fergus County, Montana," prepared for Montana DEQ, Permitting and Compliance Division. July 15.
- CDM, Inc. 2004. "Final Technical Memorandum, Hydrogeologic Data Summary, Environmental Impact Statement, CR Kendall Mine, Fergus County, Montana". Prepared for Montana DEQ, Permitting and Compliance Division. February 24.

3.4.1 Climate

Climatic conditions play a major role in the availability of surface water and the evapotranspiration and recharge of groundwater at the CR Kendall Mine. Rainfall monitoring has been conducted at the mine site since 1992. Mean annual precipitation for the period from 1993 through 2005 was 23.0 inches (584 mm) (CR Kendall, 2006). Regional precipitation data for nearby monitoring stations are summarized in Table 3-3 [CRK – please update this table thru 2005]. These data indicate that for the 1990 to 2001 period, the Fergus County area and the Kendall Mine site have experienced an extended precipitation deficit (drought).

Table 3-3
Precipitation Data CR Kendall Mine Area, Fergus County, Montana

Station	Precipitation Period of Record	Average Precipitation (inches)	Years of Complete Data Record (1990-2001)	Number of Years of below Average Precipitation (1990-2001)	Range of Annual Precipitation Deficit (inches)
Winifred	1948-2001	15.3	12	8	0.2-4.5
Moccasin	1909-2001	15.4	12	7	1.8-4.5
Roy	1948-2001	13.9	11	5	0.1-3.7
Grass Range	1948-2001	16.3	11	5	0.5-4.5
Denton	1948-2001	15.1	12	9	0.8-4.8
CR Kendall Mine	1992-2001	22.4	9	5	0.2-6.0
Harrell Ranch	1994-2001	21.0	8	4	1.3-5.1

Notes: Compiled by Gallagher (2002)

Precipitation data from the Kendall Mine reported by WMC (1999) for 1992 to 1998 indicate that 55 percent of the annual precipitation occurs during the late spring and early summer, and only 11 percent occurs during the winter months of December through February. The average annual temperature at Lewistown is 42.68 degrees Fahrenheit (°F) with the average monthly low temperature of 19.52 °F occurring in January and the average maximum temperature of 65.30 °F in July [CITE NEEDED].

3.4.2 Water Quantity

3.4.2.1 Surface Water Quantity

The North Moccasin Mountains reach an elevation of slightly over 5,600 feet, and lie on a surface water drainage divide between the Judith and Missouri River Basins. Surface water in the CR Kendall Mine area is primarily composed of runoff from snowmelt and storm water in ephemeral drainages, some of which also receive supplemental flow from groundwater discharge as springs and seeps. The majority of surface flow from the upper portion of the North Moccasin Mountains watershed is intercepted by porous and possibly karstic[4] lower Madison Limestone and little or no runoff reaches the mine or lower sections of the drainages.

Six surface drainage systems are present within the mine permit boundary and generally trend east to southeast (Figure 1-2). These drainages located from north to south are:

- South Fork of Last Chance Creek
- Mason Canyon
- North Fork of Last Chance Creek
- Barnes-King Gulch
- Little Dog Creek
- Dog Creek

The majority of the headwaters area for the South and North Forks of Last Chance Creek and Barnes-King Gulch are within the mine permit boundary. The headwaters areas of Mason Canyon, Little Dog Creek, and Dog Creek lie above the mine permit boundary at higher elevations. The Little Dog and Dog Creek drainages flow towards the Missouri River while the remaining drainages from the mine flow towards the Judith River.

Surface water monitoring has been conducted at seven surface water monitoring stations within the mine permit boundary that were established beginning in 1989 (KVSW-1 through KVSW-7) (Figure 3-1). Instantaneous flow measurements collected at the stations between 1990 and 2005 are summarized in Table 3-4 (CR Kendall 2006). In general, the stations had maximum flow in the wetter spring months followed by declining flows over the summer to little or no flow in the fall months. All stations exhibited periods of no flow.

Comment [HS22]: Need reference in Chapter 9…

Continuous flow measurements over several months were only available in the southern drainages. Analysis of one storm event in August 1996 indicated little groundwater recharge (gain) in the drainages from the storm event. WMC (1999) reported that no surface water was

[4] Limestone formation containing caves and sinkholes.

observed in the drainages above the mine in the North Moccasin Mountains and that flows above the mine are lost as recharge into the Madison Limestone. This was also observed during a site inspection in June 2003 downstream of Little Dog Spring where all surface flow was lost in the drainage at the Madison Limestone contact with the syenite porphyry (DEQ 2003 inspection report).

The average precipitation reported for the Kendall Mine site for 1993 to 2005 was 23.08 inches. Gallagher (2002) documented drought conditions that persisted in the area between 1990 and 2001. The majority of annual precipitation occurs in May, June, and July. The cumulative precipitation deficit for the 1990-2001 period ranged from 0.17 to 6.03 inches and closely reflects precipitation patterns from other weather stations in the Fergus County area (Table 3-3). Hydrologic drought, such as declining groundwater levels due to decreased recharge and increased water loss through evaporation and plant uptake, is a major contributing factor in decreased spring and ephemeral stream flows reported in the drainages originating on or crossing the mine site.

Since 2001, precipitation at the Kendall Mine has been above average for 3 out of the last 4 years (CR Kendall 2006). Surface water flows at several monitoring sites have increased since the drought ended in 2001 (Ibid.).

Figure 3-1

Show outline of major facilities

Add Mason Canyon and Little Dog Springs

Label Little Dog Creek (down below), South Fork Last Chance Creek

Show stream traces in blue

Scout Pond should be Boy Scout Pond

S. Fork Inlet should be the inlet to the Boy Scout Pond

Add monitoring sites KVSW-5, TSW-1, TPO-1, BKSW-1, #12 (off the map?), Tailings Pond, and #4 (off the map?)

Table 3-4
Summary of Instantaneous Streamflow Measurements (1990-2005)
CR Kendall Mine, Fergus County, Montana

Station Number	Drainage	Number of Events	Number of Events with Flow	Average Flow (gpm)	Maximum Flow (gpm)	Minimum Flow (gpm)
KVSW-1	North Fork Little Dog Creek	55	1	0.04	2	0
KVSW-2	Barnes-King Gulch	124	20	0.84	31.1	0
KVSW-3	North Fork Last Chance Creek	49	11	1.77	35.0	0
KVSW-4	Mason Canyon	122	73	5.5	100.0	0
KVSW-5	South Fork Last Chance Creek	113	84	8.5	76.3	0
KVSW-6	South Fork Little Dog Creek	64	1	0.4	25.1	0
KVSW-7	Mason Canyon LAD Area	90	75	7.5	50.0	0

Notes: gpm = gallons per minute

3.4.2.2 Groundwater Quantity

Groundwater was not encountered in the pits during modern mining operations at the Kendall Mine. All mine pits are dry indicating modern mining did not intercept the water table in the Madison Limestone. In addition, no groundwater discharge from historic underground workings was reported in the literature. There is no information to indicate that historic workings extended deeper than modern open pit operations. Historic mining operations and the town of Kendall obtained water supply from Little Dog Spring located above the mine and from water pumped from Warm Spring located approximately four miles to the south on the south flank of the mountains (Figure 3-1a—Regional Geology and Regional Water Sampling Locations). [KENDALL PLEASE VERIFY THIS INFORMATION]

Springs and seeps are present above and below the CR Kendall Mine site and are derived from shallow flow systems as there are no elevated water temperatures present (Figure 3-1). If the water originated in a deep aquifer, higher temperatures, characteristic of deep waters, would be observed. Springs located above the mine, such as Little Dog Spring, originate from the Tertiary syenite recharged from precipitation higher in the North Moccasin Mountains. A portion of Upper Little Dog Spring is currently diverted for augmentation in lower Little Dog Creek. The portion of Upper Little Dog Spring discharge that is not diverted does not reach the mine and is lost as recharge to the Madison Limestone. Similarly, the smaller Mason Canyon Spring discharge is also lost to recharge into the Madison Limestone. No flow from Mason Canyon into the Kendall Pit has ever been observed.

[Insert table and text on flows from Mason Canyon and Upper Little Dog springs here]

Springs located in the drainages east and downgradient of the mine site appear to be related to low permeability units in the bedrock aquifers, Morrison and Kootenai Formations, in combination with groundwater movement in the alluvial aquifer sediments. Springs of this type have small recharge areas with short flow paths. These springs are highly susceptible to small fluctuations in water table elevation resulting in variable seasonal discharge. Fluctuations in water table elevation may result from one or more factors including increased groundwater withdrawal, seasonal recharge variations, decreasing recharge from precipitation due to drought, variations in agricultural practices, beaver activity, and increased evapotranspiration.

Other small springs and seeps appear to be associated with discharge from low permeability bedrock units of the Morrison Formation which perch infiltrating groundwater and direct it laterally to excavation cuts and on slopes. WMC (1999) indicated that most of the water in the seeps is derived from local recharge sources.

Mine Pumpback, Monitoring, and Water Supply Wells

CR Kendall has installed four groundwater pumpback systems to capture contaminated seepage below waste rock dumps and the heap leach pads (Table 3-XX). The pumpback volumes have increased from an average of 22,330,000 gallons during the period 1997 through 2001 to an average of 34,987,000 gallons during the period 2002 through 2005 (CR Kendall 2006).

Table 3-XX
Pumpback Volumes (Gallons) by Year in Four Drainages (1997-2005)

Year	South Fork Last Chance Creek	Mason Canyon	Barnes-King Gulch	South Fork Little Dog Creek
1997	6,432,390	6,152,471	3,367,715	8,030,050
1998	5,678,400	6,886,823	2,613,020	8,152,220
1999	4,367,690	7,226,157	3,149,815	8,253,945
2000	4,194,260	7,559,250	3,409,090	8,536,600
2001	3,358,183	5,494,520	2,651,320	6,013,080
2002	4,739,810	8,473,350	5,491,790	11,309,340
2003	6,348,430	10,427,810	7,741,060	14,774,970
2004	6,669,470	11,868,690	8,435,590	12,666,700
2005	5,800,870	7,884,930	6,827,790	10,488,730

The company has installed numerous monitoring wells and water supply wells that date back to 1985. Most monitoring wells are located in the vicinity of the pump-back systems or are located in the process valley to monitor the former heap leach pads for leaks. A summary of well completion data and lithology for the mine site monitoring and water supply wells is presented in Appendix E, Table E-1. All monitoring wells are less than 100 feet deep and are screened in the shallow alluvium or into the first bedrock formation encountered. [UPDATE TABLE IN APPENDIX E TO ADD STATUS—I.E. ACTIVE OR ABANDONED/REMOVED] Water levels in several monitoring wells have increased since the drought ended in 2002 (CR Kendall 2006).

Eight water supply wells were drilled on the mine site. Two water supply wells, WW-6 and WW-7, are currently in use to augment surface flows in the South Fork of Last Chance Creek and in Little Dog Creek. Well log information indicated that both wells are completed in the Rierdon and Piper formations (see Appendix E, Table E-2). The static water level in WW-7 was near or above the ground surface since mid 2002. [insert table showing history of augmentation volumes for each drainage.]

Table 3-XX
Augmentation Volumes (Gallons) by Year in Two Drainages

Year	South Fork Last Chance Creek	South Fork Little Dog Creek
1997		
1998		
1999		
2000		
2001		
2002		
2003		
2004		
2005		

3.4.3 Geochemistry

In a mineralized zone, metals are elevated. Described below are the properties of the contaminants found in the geologic materials, reclamation resources, and water at the Kendall Mine. The probable source, forms, and fate and transport are described for each element.

3.4.3.1 Arsenic

Arsenic is present in the ore body mined by CR Kendall and within the surrounding rocks, which were influenced by the emplacement of the ore body. Elevated background levels of arsenic around some gold-bearing ore bodies is well known and is often used in prospecting (Cite needed). Arsenic occurs in two oxidation states, arsenic(+3) and arsenic(+5). Arsenic(+5), the more oxidized state, is less mobile in water than arsenic(+3). Arsenic is removed from solution by the oxidation of arsenic and co-precipitation with naturally occurring ferrous iron onto sediments. This often occurs when iron- and arsenic-bearing waters are oxidized down-gradient of the source.

The mobility of arsenic varies with pH as well. At high pH, arsenic does not adsorb onto soil and sediment surfaces as well as it does at lower pH levels. Cyanide leaching requires raising the pH of process solution to greater than 10, which mobilizes arsenic. The increased mobility of arsenic in the heap leach pads combined with the high concentrations in the ore results in high arsenic levels (approximately 0.2 mg/L) in heap leach pad effluent.

3.4.3.2 Selenium

Selenium exists in local geologic materials, probably as an impurity in sulfide minerals such as pyrite. The selenium is released into solution by oxidation of the sulfide minerals within the leach pads or waste rock dumps. The historic tailings were reportedly roasted prior to leaching, which may have driven off selenium as a gas to some extent. Selenium distribution varies across the site. Little Dog Creek has higher selenium concentrations in water than other mine-site drainages.

Selenium is adsorbed by silica, or co-precipitated with iron or aluminum oxyhydroxides. When sulfate is present in the water, such as at the CR Kendall Mine site, selenium adsorption is partially inhibited due to competition for adsorption sites on soils and sediments down-gradient of the source. The higher the sulfate concentration relative to selenium, the less selenium adsorption will take place and the more mobile selenium will be. Selenium adsorption also decreases with increasing pH. [KENT—need short write up on different oxidation states.]

3.4.3.3 Thallium

Thallium was deposited at the same time as the gold in the mineralized rock at the Kendall Mine. Thallium is present in pyrite and other minerals. Weathering of these minerals releases thallium into mine drainage and stormwater from the site. [Confirm w/Ed Surbrugg]

Thallium occurs in two oxidation states in natural water: thallium(+1) and thallium(+3). Thallium(+1) behaves similarly to the alkali metals (sodium, potassium, etc.) and as such, is fairly mobile. Thallium (+3) behaves similarly to aluminum and co-precipitates with iron oxyhydroxides during neutralization and aeration of the water downgradient of the source.

3.4.3.4 Nitrogen

The most important forms of nitrogen in natural waters are ammonia (NH_3), nitrite (NO_2^-), nitrate (NO_3^-), and various nitrogen-bearing organic compounds. The most important forms of nitrogen at the site are nitrite and nitrate, which are usually reported by analytical laboratories as the sum of the two species due to holding time constraints. Nitrates in the following discussion will include nitrate and nitrite.

Nitrates at the Kendall Mine are derived from a number of sources including degradation of cyanide, explosives used in blasting, oxidation of organic matter, and run-off from fertilized areas. During operations residues from blasting was the primary source of nitrates. Since operations have ceased, degradation of cyanide is the major source of nitrates in the process valley and LAD areas.

Nitrates can be converted to nitrogen gas by bacteria under low oxygen conditions provided a source of organic carbon is present, such as in wetland areas. Under oxidizing conditions, nitrates tend to persist and are relatively mobile in the environment. Plants use nitrogen as a nutrient and can remove nitrates from water by uptake through roots.

3.4.3.5 Cyanide

Cyanide (CN^-) was used by CR Kendall to dissolve gold from the crushed ore within the heap leach pads, located in Mason Canyon. The gold-bearing solution was collected from the heap leach pads and conveyed to the processing plant where the gold was separated from the cyanide. The cyanide solution was recycled back to the heap leach pads. Cyanide was used by the historic mills located in Little Dog Creek, Barnes-King Gulch, and Mason Canyon as previously discussed in Chapter 1.

Dissolved cyanide exists as free cyanide (HCN), weak acid dissociable (WAD) cyanide, and strong cyanide complexes, such as iron cyanide. Free cyanide, the most toxic form, generally does not persist in the environment due to loss by vaporization, biodegradation, and degradation by sunlight. Strong cyanide complexes tend to persist, but are generally less toxic. Water quality analyses usually measure total cyanide that includes all forms of cyanide. Montana water quality standards conservatively assume total cyanide is equivalent to free cyanide.

3.4.4 Water Quality

Overall quality of site waters is expressed in terms of concentration ranges and the percentage of the time parameters of concern have exceeded water quality standards. This is a summary of data presented elsewhere (WMC 1999 and 2003, Gallagher 2002, CDM 2004c, CR Kendall 2006). Surface water quality standards for metals are based on total recoverable concentrations, which includes dissolved and suspended components. Since 1994, CR Kendall has obtained both dissolved and total recoverable analyses for surface water samples. Groundwater quality standards for metals are based solely on dissolved concentrations.

3.4.4.1 Process Water Chemistry

Several lined process ponds containing cyanide solutions and/or mine drainage pumpback water are present within the process valley in Mason Canyon. The pregnant pond, Pond 7, contains water draining from the heap leach pads. The quality of the water in the pregnant pond is presented in Table 3-5 below. Water quality standards do not apply to the water in the pregnant pond until the water is discharged. Prior to discharge, process water has historically been treated using either sodium hypochlorite or hydrogen peroxide to reduce cyanide levels or treated with reverse osmosis or zeolite filtration to remove other contaminants to make it suitable for LAD or discharge to groundwater beneath the mine pits.

Table 3-5
Analyses for Pregnant Pond 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data[3]	% of Data Exceeding Standards	Recent (8/23/05)
SC (μmho/cm)	---	2380-5370	---	3590
Sulfate	---	554-2510	---	1690
Cyanide as total	0.0052	**0.12-291**	100	**0.77**
Nitrate/nitrite as N	10	0.17-**195**	83.6	**96.7**
Arsenic	0.018	**0.134-0.390**	100	**0.189**
Iron	1.0	0.06-0.46	0	NA[4]
Selenium	0.005	**0.043-0.182**	100	**0.077**

Thallium	0.0017	**0.38-1.45**	100	**0.894**
Zinc	0.388 @ >400 mg/L hardness	0.01-**33.3**	43.5	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1] Units are mg/L unless otherwise noted (metals are dissolved and total recoverable concentrations combined).
[2] The lowest value between the human health surface water and chronic aquatic standards.
[3] Data from February 1990 to August 2005.
[4]NA = not analyzed, removed from the monitoring plan.

3.4.4.2 Surface Water Quality

The default surface water classification for streams in Montana is B-1, which means they are assumed to be suitable for drinking water and human health drinking water standards apply. The six drainages leaving the CR Kendall permit boundary are ephemeral or intermittent. Sampling locations have been modified over time due to expansion of and changes to mine facilities. Data from sampling locations are sporadic due to freezing or lack of the surface water at the designated sampling stations. A summary of the surface water sampling locations and the time periods in which they were sampled is shown in Table 3-6 below.

Table 3-6
Surface Water Sampling Locations and Years Sampled by Drainage

Drainage	Stream Water Locations	Pond Water Locations
South Fork Last Chance Creek	KVSW-5 (1994-2005), KVSW-5E (1996), KVSW-5W (1996), S Fork Boundary (1997-2001), S Fork Fence (1996-97), S Fork Inlet (1999)	Boy Scout Pond (1990, 1996, 1998-2005)
Mason Canyon	TSW-1 (1984-85), KVSW-4 (1990-2005), KVSW-7 (1994-2005)	TPO-1 (1984-86)
North Fork Last Chance Creek	TSW-2 (1982-85), KVSW-3 (1990-2005)	TPO-2 (1984-86), Peters Pond #1 (2001)
Barnes-King Creek	TSW-3 (1984-85), KVSW-2 (1990-2005), BKSW-1 (2001)	
Little Dog Creek	TSW-4 (1984-85), KVSW-1 (1991), KVSW-6 (1995), #1 (1998), #14 (1998), #15 (1998), Section 29 Spring (1981-82, 1984-86, 1989-91, 1993-2005)	#12 (1998), TPO-3 (1984-86), Tailings Pond (2002)
Dog Creek	#3 (1998), #6 (1998), #10 (1998)	#2 (1998), #4 (1998), #5 (1998), #7 (1998)

The location of each sampling point is shown on Figure 3-1. The surface water quality within each of the six drainages is presented in the following sections. The tables for each sampling station compare the concentrations of each parameter of concern to the human health or chronic aquatic life water quality standards, whichever is more stringent.

South Fork Last Chance Creek

The water quality results for surface water station KVSW-5 in the South Fork Last Chance Creek are shown in Table 3-7. Average thallium concentrations have been reduced by 80 percent since pumpback was initiated in 1996 but still exceed the human health standard.

Table 3-7
Analyses for Surface Water Station KVSW-5 in South Fork Last Chance Creek 1994-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentrations		Recent (11/15/05)
				Before Pumpback	After Pumpback	
SC (μmho/cm)[3]	---	1000-2250	---	1742	1617	1840
Sulfate[3]	---	430-1240	---	772	736	856
Nitrate/nitrite as N[3]	10	1.89-6.05	0	4.43	3.26	2.63
Cyanide as total	0.0052	<0.005-**3.36**[5]	0	<0.005	<0.005	<0.005
Arsenic[4]	0.018	<0.003-**0.02**	1.0	0.006	0.004	<0.003
Iron[4]	1.0	<0.01-**2.92**	10	0.26	0.44	NA[6]
Selenium[4]	0.005	<0.001-**0.007**	3.1	0.003	0.002	0.002
Thallium[4]	0.0017	**0.002-0.05**	100	**0.021**	**0.004**	**0.002**
Zinc[4]	0.388 @ >400 mg/L hardness	0.005-0.14	0	0.022	0.033	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic life criteria.
[3]Data from May1994 to November 2005.
[4]Total recoverable metals data from May 1994 to November 2005.
[5]Sample error with very first sample, as cyanide has never been detected since.
[6]NA = not analyzed, removed from the monitoring plan.

The analytical results for the Boy Scout pond water are presented in Table 3-8. Arsenic is the only parameter that frequently has exceeded the human health standard.

Table 3-8
Water Analyses – Boy Scout Pond 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Recent (11/15/05)
SC (μmho/cm)[3]	---	174-1420	---	972
Sulfate[3]	---	36-601	---	373
Nitrate/nitrite as N[3]	10	<0.01-1.18	0	<0.01
Cyanide as total	0.0052	<0.005-**0.6**[5]	0	<0.005[6]
Arsenic[4]	0.018	<0.003-**0.05**	55.0	0.009
Iron[4]	1.0	<0.01-**1.78**	16.7	NA[7]
Selenium[4]	0.005	<0.001-0.003	0	<0.001
Thallium[4]	0.0017	**<0.002-0.004**	3.3	<0.002
Zinc[4]	0.388 @ >400 mg/L hardness	0.005-0.02	0	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.

[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic life criteria.
[3]Data from May 1990 to November 2005.
[4]Total recoverable metals data from May 1990 to November 2005
[5]Sample error with very first sample, as cyanide has never been detected since.
[6]Most recent sample for cyanide was collected on 5/19/1998.
[7]NA = not analyzed, removed from the monitoring plan.

The source of the arsenic within the pond is believed to be from sediments transported down the South Fork Last Chance Creek during storm events. Sources of this sediment may include material eroded from the Kendall Waste Rock Dump, historic mine waste rock or tailings, or natural sources of sediment eroding from the mineralized zone. South Fork Last Chance Creek sediment sample results, collected by DEQ in April 1998, are shown in Table 3-9.

Table 3-9
Arsenic in Sediment from Samples Collected by DEQ in April 1998 (DEQ 1998a)

Sample ID	Location	Arsenic Concentration (mg/kg)
CRK-1	Within the Boy Scout Pond	98
CRK-2	Areas adjacent to the pond and SFLCC[1]	8.4
CRK-3	Sediment within SFLCC	128
CRK-4	Areas adjacent to the pond and SFLCC	26
CRK-5	Areas adjacent to the pond and SFLCC	8.0
CRK-6	Sediment within SFLCC	138
CRK-7	Sediment within SFLCC	132

[1]SFLCC means South Fork Last Chance Creek

The results indicate that the sediments collected from within the South Fork Last Chance Creek channel (CRK-3, CRK-6, and CRK-7) have 5 to 16 times higher arsenic concentrations than areas adjacent to the Boy Scout Pond and South Fork Last Chance Creek (CRK-2, CRK-4, and CRK-5). The presence of dissolved arsenic above the human health standard in the Boy Scout Pond but not in the surface waters of South Fork Last Chance Creek, as measured at KVSW-5, suggests that arsenic is being leached from sediment that has been washed into the pond under reducing conditions present in the bottom of the pond. Because reducing conditions are not present in the surface waters at KVSW-5, arsenic is not mobilized within the drainage to the same extent as at the bottom of the pond.

The Harrell and Jack Ruckman ponds on a tributary of the South Fork Last Chance Creek were sampled in July 2003 and were found to be within water quality standards for all parameters (CDM 2003). Both ponds are downgradient from the Boy Scout Pond.

Mason Canyon

The water quality results for surface water station KVSW-4 in Mason Canyon is shown in Table 3-10. Based on these data, the pumpback system has improved surface water quality at KVSW-4, except when the creek is turbid due to stormwater runoff. Station KVSW-4 is located downstream of the process valley below TMW-26 and the stormwater settling pond (Figure 3-1). Thallium concentrations generally exceed the human health standard, but there has been a 45 percent reduction in average concentration since the initiation of pumpback. This may also be related to historic tailings removal between the leach pads and KVSW-4. Elevated cyanide concentrations before pumpback were related to spills in the process valley during operations. Average cyanide concentrations have dropped 96 percent since initiation of pumpback and are below the chronic aquatic life standard. Prior to initiation of pumpback from the TMW-26 underdrain sump in the process valley, arsenic concentrations at KVSW-4 did not exceed the human health standard. After the pumpback system was installed, arsenic sometimes exceeded standards when the creek was turbid. Selenium and iron sometimes exceed the chronic aquatic life standards at this station when the creek was turbid. The average selenium concentrations before and after pumpback are below the standards.

Table 3-10
Analyses for Surface Water Station KVSW-4 in Mason Canyon (Process Valley) 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentrations		Recent (09/20/05)
				Before Pumpback	After Pumpback	
SC (μmho/cm)[3]	---	93-1320	---	1039	733	897
Sulfate[3]	---	12-321	---	210	131	114
Nitrate/nitrite as N[3]	10	<0.01-**10.8**	1.1	2.76	0.66	0.03
Cyanide as total	0.0052	<0.005-**1.26**	40	**0.094**	0.004	<0.005
Chloride	---	2-60	---	24.2	12.3	7.0[5]
Arsenic[4]	0.018	<0.03-**0.398**	14.1	0.012	**0.02**	0.012
Iron[4]	1.0	<0.03-**57.8**	11.4	**2.50**	**3.65**	NA[6]
Selenium[4]	0.005	0.001-**0.017**	15.6	0.004	0.002	<0.001
Thallium[4]	0.0017	0.001-**0.149**	97.3	**0.038**	**0.021**	**0.015**
Zinc[4]	0.388 @ >400 mg/L hardness	0.005-0.33	0	0.049	0.024	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic standards.
[3]Data from May 1990 to September 2005; data from 1984-86 were collected from TSW-1 located further upstream.
[4]Total recoverable metals data from May 1990 to September 2005
[5]Most recent sample for chloride was collected on 11/17/1998; chloride has been removed from the monitoring plan.
[6]NA = not analyzed, removed from the monitoring plan.

The water quality results for surface water station KVSW-7 in a tributary of Mason Canyon is shown in Table 3-11. KVSW-7 was established in 1994 downgradient of the LAD site used for disposal of treated process water in 1993. The LAD site was also used for disposal of waste rock dump seepage during 1997 through 1998. [CDM copy or generate graphs in Ch 4 to show trends for cyanide, nitrates, and chloride and other paramaters.] Trends in data since 1994 show a decline in concentrations in most paramenters since the cessation of LAD, except when the creek is turbid due to stormwater runoff

Table 3-11
Analyses for Surface Water Station KVSW-7 in Mason Canyon (Process Valley) 1994-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Samples	Recent

			Exceeding Standards	(09/20/05)
SC (μmho/cm)[3]	---	687-1300	---	814
Sulfate[3]	---	52-154	---	65
Nitrate/nitrite as N[3]	10	0.17-3.23	0	0.32
Cyanide as total	0.0052	<0.005-**0.093**	32	<0.005
Chloride[5]	---	48-164	---	49
Arsenic[4]	0.018	<0.003-**0.287**	16.0	<0.003
Iron[4]	1.0	0.06-**69.9**	14.3	NA[6]
Selenium[4]	0.005	<0.001-**0.007**	6.7	<0.001
Thallium[4]	0.0017	0.001-**0.032**	28.0	0.001
Zinc[4]	0.388 @ >400 mg/L hardness	0.005-0.180	0	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic standards.
[3]Data from May 1994 to September 2005.
[4]Total recoverable metals data from May 1994 to September 2005.
[5]Most recent sample for chloride was collected on 11/18/1998, chloride has been removed from the monitoring plan.
[6]NA = not analyzed, removed from the monitoring plan.

[Insert table and text on Mason Canyon spring here]

North Fork Last Chance Creek

The water quality results for surface water station KVSW-3 in the North Fork Last Chance Creek are shown in Table 3-12. CR Kendall has not disturbed lands in this drainage. Grayhall Resources constructed two small waste rock dumps at the head of this drainage adjacent to Barnes-King Pit. These waste rock dumps were reclaimed in the late 1980s. There is no pumpback in the North Fork Last Chance Creek drainage. Concentrations of selenium have exceeded the chronic aquatic life standard by up to twice the standard. Thallium concentrations exceeded the human health standard by up to four times the standard. Elevated levels of arsenic and iron occurred when the stream was turbid due to stormwater runoff. These levels may represent background conditions.

Table 3-12
Analyses for Surface Water Station KVSW-3 in North Fork Last Chance Creek 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Data Exceeding Standards	Recent (05/24/05)
SC (μmho/cm)[3]	---	757-1040	---	1070
Sulfate[3]	---	110-252	---	289
Nitrate/nitrite as N[3]	10	<0.05-4.29	0	<0.01
Cyanide as total[5]	0.0052	<0.005-0.005	0	<0.005
Chloride[5]	---	2-48	---	27.0
Arsenic[4]	0.018	0.005-**0.19**	13.3	0.006
Iron[4]	1.0	0.11-**75.2**	27.3	NA[6]
Selenium[4]	0.005	0.002-**0.01**	40.0	0.004
Thallium[4]	0.0017	<0.002-**0.008**	90.9	**0.005**
Zinc[4]	0.388 @ >400	<0.01-0.120	0	NA

	mg/L hardness				

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic standards.
[3]Data from May 1990 to May 2005.
[4]Total recoverable metals data from May 1990 to May 2005.
[5]Most recent samples for cyanide and chloride were collected on 5/14/1996; both parameters have been removed from the monitoring plan for this station.
[6]NA = not analyzed, removed from monitoring plan.

Barnes-King Gulch

The water quality results for surface water station KVSW-2 in Barnes-King Gulch are shown in Table 3-13. The station is located below the South Muleshoe Waste Rock Dump, which was constructed over historic tailings from the Barnes-King mill. Historic tailings between the toe of the waste rock dump and permit boundary were removed in 1997. The data collected since pumpback system KVPB-2 was put into service have been sparse due to a lack of water at the sampling location. Although thallium consistently exceeds the human health standard, the average concentration has been reduced by 75 percent since the initiation of pumpback. Average concentrations of all other parameters have also improved since pumpback was initiated. In part, the improvement is due to the removal of the historic tailings over which waste rock dump seepage and stormwater runoff flowed.

Table 3-13
Analyses for Surface Water Station KVSW-2 in Barnes-King Gulch 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Data Exceeding Standards	Average Concentrations		Recent (06/23/05)
				Before Pumpback	After Pumpback	
SC (μmho/cm)[3]	---	300-2170	---	1971	914	739
Sulfate[3]	---	29-1230	---	1014	381	153
Nitrate/nitrite as N[3]	10	<0.005-5.99	0	2.42	0.59	0.02
Cyanide as total	0.0052	<0.005-**0.01**	45.5	**0.006**	NA[5]	0.005[6]
Chloride	---	5-13	---	9.3	NA	9.0[6]
Arsenic[4]	0.018	0.005-**0.167**	65.0	**0.092**	**0.022**	**0.04**
Iron[4]	1.0	0.015-**2.57**	54.5	**1.24**	**1.07**	NA
Selenium[4]	0.005	0.002-**0.045**	60.0	**0.015**	**0.007**	0.002
Thallium[4]	0.0017	**0.013-0.549**	100	**0.41**	**0.103**	**0.038**
Zinc[4]	0.388 @ >400 mg/L hardness	0.04-0.28	0	0.20	0.04	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic standards.
[3]Data from May 1990 to June 2005
[4]Total recoverable metals data from May 1990 to June 2005.
[5]NA = not analyzed, removed from the monitoring plan for this station.
[6]Most recent samples for cyanide and chloride were collected on 5/14/1996; both parameters have been removed from the monitoring plan for this station.

Little Dog Creek

Two surface water monitoring stations and one spring (Section 29 spring) are monitored in Little Dog Creek, but few water quality data are available for the surface water sites due to the ephemeral nature of this drainage near the mine site. Additional data have been collected from Upper Little Dog Spring.

The data from surface water stations KVSW-1 and KVSW-6 are presented in Table 3-14 below. KVSW-1 is located downgradient of the Horseshoe Waste Rock Dump in the North Fork Little Dog Creek. KVSW-6 is located downgradient of the North Muleshoe Waste Rock Dump in the South Fork Little Dog Creek. Flows at KVSW-1 and KVSW-6 have only been observed and sampled once, in 1991 and 1995, respectively. The samples exceeded water quality standards for some parameters as shown in the table below. The only samples obtained from these two stations probably occurred as a result of stormwater runoff. The operation of the pumpback system since 1996 has intercepted flows above KVSW-6.

Table 3-14
Analyses for Surface Water Stations KVSW-1 and KVSW-6 in Little Dog Creek

Parameter[1]	WQB-7 Criteria[2]	KVSW-1 5/29/1991	KVSW-6 5/16/1995
SC (μmho/cm)	---	2490	2240
Sulfate	---	1500	1220
Nitrate/nitrite as N	10	7.76	**25.4**
Cyanide as total	0.0052	**0.007**	<0.005
Chloride	---	8	20
Arsenic	0.018	**0.037**	0.006
Iron	1.0	0.38	<0.03
Selenium	0.005	**0.053**	**0.036**
Thallium	0.0017	NA[3]	**0.28**
Zinc	0.388 @ >400 mg/L hardness	0.06	0.05

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1] Units are mg/L unless otherwise noted (metals are total recoverable).
[2] The lowest value between the human health surface water and chronic aquatic standards.
[3] NA = not analyzed.

The data from the Section 29 spring are presented in Table 3-15 below. The Section 29 spring is located below the confluence of the north and south forks of Little Dog Creek and below the historic tailings pond in the North Fork Little Dog Creek (Figure 3-1). Nitrates, sulfate and selenium concentrations increased after the North Muleshoe Waste Rock Dump was developed. Nitrate concentration rose from an average background concentration of approximately 1 mg/L to a high of 14 mg/L after the dump was constructed but before the pumpback system was installed. The most recent nitrate sample is 80 percent lower than the highest sample recorded, which exceeded the human health standard. The average concentrations of most parameters remained relatively constant before and after pumpback. Selenium generally exceeded chronic aquatic life criteria since 1994.

This spring represents the beginning of intermittent surface flows downgradient of the mine. This spring has been developed and discharges to a stock tank. Installation of pumpback system KVPB-6 had reduced flow of this spring. Consequently, CR Kendall augments flow to this spring from WW-7 and Upper Little Dog Spring. Flow augmentation occurs below the Section 29 spring sampling point to avoid influencing water quality monitoring results for the spring.

Table 3-15
Analyses for Section 29 Spring in Little Dog Creek 1990-2005

Parameter[1]	WQB-7 Criteria[2]	Range of Data	% of Data Exceeding Standards	Average Concentrations		Recent (9/19/05)
				Before Pumpback	After Pumpback	
SC (µmho/cm)[3]	---	801-1900	---	1453	1408	1460
Sulfate[3]	---	61-768	---	516	537	562
Nitrate/nitrite as N[3]	10	0.55-**14.1**	6.4	5.97	5.31	2.75
Cyanide as total	0.0052	<0.005	0	<0.005	--	--
Arsenic[4]	0.018	<0.003-0.005	0	<0.004	0.002	<0.003
Iron[4]	1.0	<0.01-0.02	0	0.018	0.019	NA[5]
Selenium[4]	0.005	<0.001-**0.013**	92.3	**0.006**	**0.008**	0.009
Thallium[4]	0.0017	<0.002-**0.029**	5.3	<0.002	0.0016	<0.002
Zinc[4]	0.388 @ >400 mg/L hardness	<0.01-0.03	0	0.018	0.009	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the human health surface water and chronic aquatic standards.
[3]Data from May 1990 to June 2005.
[4]Total recoverable metals data from May 1990 to June 2005.
[5]NA = not analyzed, removed from monitoring plan.

[Insert table and text on Upper Little Dog Spring here.]

Water Environment Technologies (WET) (2002) collected a water sample in the historic tailings pond in 2002. This pond is located downgradient of the Horseshoe Waste Rock Dump and KVSW-1 and is upgradient of the Section 29 spring. Arsenic was measured at 0.078 mg/L and thallium was measured at 0.003 mg/L. These values cannot be compared to human health standards for surface water because the analytical method used was not the method required to evaluate Montana water quality standards (DEQ 2004). These samples were analyzed for total metals, while the standard is based on total recoverable metals.

Dog Creek

The Dog Creek drainage is located north of the Kendall Mine site. XXX acres of the Horseshoe Pit extend into this watershed. No water monitoring stations have been established in this drainage. Several sites in this drainage were sampled by DEQ in 1998 for purposes of estimating background water quality (Figure 3-___ [regional map showing N. Moccasin Mtns, geology of mine site, off-site water monitoring locations, including Vaneck Warm Spring, Little Dog Spring, Mason Canyon Spring; derived from Plan 1 map Gallagher's 2002 report]). The results of the stream and stock pond water sampling are shown in Tables 3-15 and 3-16 below. All surface water samples from Dog Creek were within human health and chronic aquatic life standards except for iron in surface water site #10 and stock pond #7, which slightly exceeds chronic aquatic life standards.

Table 3-16
Analyses for Surface Water Sites in Dog Creek[1]

Parameter	WQB-7 Criteria[2]	Concentration (mg/L unless noted otherwise)		
		#3	#6	#10
SC (µmho/cm)	---	855	737	507
Sulfate	---	74.8	44.5	11.7
Nitrate/nitrite as N	10	N/A	N/A	N/A
Arsenic[3]	0.018	0.002	<0.001	0.006
Iron[3]	1.0	0.46	0.16	**1.11**
Selenium[3]	0.005	0.002	<0.001	<0.001
Thallium[3]	0.0017	<0.001	<0.001	<0.001

[1] Data collected by DEQ June 30, 1998.
[2] The lowest value between the human health and chronic aquatic life standards.
[3]Total recoverable metals.

Table 3-17
Analysis for Stock Ponds in Dog Creek[1]

Parameter	WQB-7 Criteria[2]	Concentration (mg/L unless noted otherwise)			
		#2	#4	#5	#7
SC (µmho/cm)	---	517	518	343	754
Sulfate	---	98.7	83.8	22.1	9.8
Arsenic[3]	0.018	0.006	0.008	0.015	<0.001
Iron[3]	1.0	0.54	0.35	0.26	**1.07**
Selenium[3]	0.005	<0.001	<0.001	<0.001	<0.001
Thallium[3]	0.0017	<0.001	<0.001	<0.001	<0.001

[1] Data collected by DEQ June 30, 1998.
[2] The lowest value between the human health and chronic aquatic life standards.
[3]Total recoverable metals. [Do we want to include CRK data from 1997-98]

3.4.4.3 Groundwater Quality

The groundwater quality beneath the CR Kendall Mine site has been monitored at 45 groundwater monitoring wells starting in 1981, of which 4 continue to be sampled on a regular basis. In addition, groundwater has been sampled at three water supply wells, four pumpback systems, and several local springs and seeps. The pumpback systems have a wide capture zone and represent a larger volume of groundwater than a monitoring well or a seep. The four remaining monitoring wells and the pumpback systems are located on the South Fork Last Chance Creek (TMW-42 and KVPB-5), Mason Canyon (process valley) (TMW-24A and TMW-26), Barnes-King Gulch (TMW-30A and KVPB-2), and South Fork Little Dog Creek (TMW-40D and KVPB-6) (Figure 3-1). These four monitoring wells are located below the pumpback systems to monitor the effectiveness of the systems. The water collected from the pumpback systems is routed, treated and disposed as described in Section 2.2.1.7.

The site groundwater exceeded WQB-7 human health standards for thallium 100 percent of the time, with an occasional nitrate (80 percent of the time for KVPB-6, 26 percent for KVPB-5 and 3 percent for TMW-26) or arsenic (11 percent of the time for KVPB-2) exceedance. [This may need to be split up and put elsewhere or revised.]

Human health standards apply to groundwater. In places where groundwater discharges to the surface from seeps and springs, the more stringent surface water standards would apply which could result in additional exceedances for some parameters.

3.4.4.3.1 South Fork Last Chance Creek

Groundwater monitoring in South Fork Last Chance Creek began in December 1989 at well TMW-31. In 1996 pumpback system KVPB-5 was constructed downgradient of this well and TMW-31 was abandoned. TMW-42 was installed downgradient of the pumpback system in 1998. The only parameter that has exceeded standards is thallium (Table 3-18).

Table 3-18
Water Analyses for Monitoring Well TMW-42, in South Fork Last Chance Creek (1998-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (11/15/05)
SC (μmho/cm)	---		1650
Sulfate	---		739
Nitrate/nitrite as N	10		1.68
Arsenic	0.020		<0.003
Iron	---		NA[3]
Selenium	0.050		0.001
Thallium	0.002		**0.003**
Zinc	2.0		NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from February 1998 to November 2005
[3]NA = not analyzed, removed from monitoring plan in 1998.

Water chemistry data for pumpback system KVPB-5 is shown in Table 3-19. The only parameters that have exceeded human health standards are nitrate and thallium. The intercepted groundwater chemistry shows seasonal fluctuations, but has generally remained constant. There has been a slight decrease in nitrates and thallium levels in KVPB-5.

Table 3-19
Water Analyses for Pumpback System KVPB-5, in South Fork Last Chance Creek (1996-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (11/14/05)
SC (μmho/cm)	---		2,910
Sulfate	---		1,800
Nitrate/nitrite as N	10		6.29
Arsenic	0.020		0.003
Iron	---		NA[3]
Selenium	0.050		0.014
Thallium	0.002		**0.023**

Zinc	2.0		NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from November 1996 to November 2005.
[3]NA = not analyzed, removed from monitoring plan in 1998.

3.4.4.3.2 Mason Canyon

Groundwater monitoring in Mason Canyon began in 1985. Since that time there have been 15 monitoring wells installed in the drainage. Most of these wells were installed to monitor for leaks from process ponds and have been removed due to expansion of mine facilities. TMW-24A was installed near the permit boundary in 1994 and continues to be monitored. The only parameter that has exceeded standards is arsenic (Table 3-20). Arsenic and iron concentrations in this well began rising in 1997. The probable source of these contaminants is historic tailings that remain in the drainage after partial tailings removal in 1997. Excavation of the historic tailings lowered the channel elevation and subsequently lowered the water table in the banks adjacent to the drainage channel creating oxidizing conditions in previously reduced tailings. Initiation of pumpback from TMW-26 in 1996 may also have lowered the local water table.

Table 3-20
Water Analyses for Groundwater Well, TMW-24A, Mason Canyon (1994-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (11/15/05)
SC (μmho/cm)	---		1110
Sulfate	---		241
Nitrate/nitrite as N	10		<0.01
Cyanide as total	0.20		<0.005
Arsenic	0.020		**0.032**
Iron	---		NA[3]
Selenium	0.050		<0.001
Thallium	0.002		<0.002
Zinc	2.0		NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from May 1994 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

Heap leach pad 4 and its underdrain system were constructed in 1989 (Section 2.2.1.1). Water flowing through the underdrain reports to a sump, TMW-26. Water chemistry data for pumpback system TMV-26 is shown in Table 3-21. Until 1996, the sump discharged into Mason Canyon except when it was pumped back in response to cyanide spills. Since 1996, the sump has been continuously pumped back. The only parameters that have exceeded groundwater human health standards are nitrate, cyanide, and thallium. Since heap leach operations have ceased only thallium continues to exceed the standard.

Table 3-21
Water Analyses for Pumpback System TMW-26, Heap Leach Pads Underdrain Sump (1990-2005)[2]

Parameter[1]	WQB-7 Criteria	Range	Recent (11/14/05)
SC (μmho/cm)	---	1030-1550	1420

Sulfate	---	253-515	395
Nitrate/nitrite as N	10	2.4-**13.0**	3.33
Cyanide as total	0.20	---	0.009
Arsenic	0.020	0.003-0.009	<0.003
Iron	---	<0.010-0.840	NA[3]
Selenium	0.050	0.002-0.024	<0.008
Thallium	0.002	**0.014-0.050**	**0.035**
Zinc	2.0	0.040-0.180	NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from August 1990 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

3.4.4.3.3 Barnes-King Gulch

Groundwater monitoring in Barnes-King Gulch began in 1990 at TMW-30. This well was replaced by TMW-30A due to concerns about well construction. TMW-30A was installed near the permit boundary in 1994 and continues to be monitored (Figure 3-1). The only parameter that sometimes exceeds standards is thallium (Table 3-22). Initiation of pumpback from KVPB-2 in 1996 has lowered the local water table and TMW-30A has been dry most of the time since 1997.

Table 3-22
Water Analyses for Groundwater Well TMW-30A, Barnes-King Gulch (1994-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (6/24/02)
SC (μmho/cm)	---		1400
Sulfate	---		555
Nitrate/nitrite as N	10		2.21
Arsenic	0.020		<0.003
Iron	---		NA[3]
Selenium	0.050		0.005
Thallium	0.002		0.002
Zinc	2.0		NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from May 1994 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

Pumpback system KVPB-2 was installed in 1996 in Barnes-King Gulch downgradient of the South Muleshoe Waste Rock Dump (Figure 3-1). Water chemistry data for pumpback system KVPB-2 is shown in Table 3-23. The parameters that have exceeded human health standards are nitrate, arsenic, and thallium. Arsenic levels are declining but nitrate and thallium levels are increasing. Increases in nitrate concentrations are due to land application of process water on the reclaimed waste rock dump. The thallium increase has been rising steadily and is probably associated with weathering of thallium-bearing minerals in the waste rock.

Table 3-23
Water Analyses for Pumpback System KVPB-2, Barnes-King Gulch (1996-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (11/14/05)

SC (μmho/cm)	---	662-3560	3040
Sulfate	---	572-1680	1640
Nitrate/nitrite as N	10	0.8- 9.9	**14.7**
Arsenic	0.020	0.006-**0.028**	0.009
Iron	---	<0.01-1.51	NA[3]
Selenium	0.050	0.006-0.024	0.009
Thallium	0.002	**0.300-1.44**	**1.64**
Zinc	2.0	0.170-0.350	NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from August 1996 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

3.4.4.3.4 Little Dog Creek

South Fork Little Dog Creek. Groundwater monitoring in South Fork Little Dog Creek began in 1994 at TMW-36. This well was replaced by TMW-40D in 1998 because TMW-36 was located too close to the pumpback system (Figure 3-1). The only parameters that have ever exceeded human health standards are nitrate and thallium (Table 3-24). Nitrate has remained relatively constant with seasonal variation.

Two water supply wells WW-6 and WW-7 are located in this drainage (Figure 3-1). These wells are 490 and 540 feet deep respectively. WW-7 is occasionally artesian in the spring after recharge. Water quality for these two wells meets human health standards and is generally below detection limits for nitrate, arsenic, selenium, and thallium. Water from these two wells is used to augment flows in South Fork Last Chance Creek and Little Dog Creek (Section 3.4.2.2).

Table 3-24
Water Analyses for Groundwater Well, TMW-40D, in Little Dog Creek (1998-2005)[2]

Parameter[1]	WQB-7 Criteria	Range of Data	Recent (11/14/05)
SC (μmho/cm)	---		2510
Sulfate	---		1320
Nitrate/nitrite as N	10		**11.7**
Arsenic	0.020		<0.003
Iron	---		NA[3]
Selenium	0.050		0.025
Thallium	0.002		<0.002
Zinc	2.0		NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from November 1998 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

Pumpback system KVPB-6 was installed in 1996 in South Fork Little Dog Creek downgradient of the North Muleshoe Waste Rock Dump (Figure 3-1). Water chemistry data for pumpback system KVPB-6 is shown in Table 3-25. This pumpback system consists of two interception trenches and three pumpback wells. The parameters that have exceeded human health standards are nitrate, selenium, and thallium. Selenium levels are increasing slightly but have generally remained below human health standards. Nitrate and thallium have remained relatively constant with seasonal variation.

Table 3-25
Water Analyses for Pumpback System, KVPB-6, in Little Dog Creek (1996-2005)[2]

Parameter[1]	WQB-7 Criteria	Range	Recent (11/14/05)
SC (μmho/cm)	---	760-2920	2830
Sulfate	---	649-1870	1640
Nitrate/nitrite as N	10	2.8-**39.8**	**13.2**
Cyanide as total	0.20	---	---
Arsenic	0.020	<0.005-0.018	0.008
Iron	---	<0.01-1.66	NA[3]
Selenium	0.050	0.008-**0.055**	0.04
Thallium	0.002	**0.159-0.820**	**0.412**
Zinc	2.0	0.030-0.120	NA[3]

Note: Bold indicates value above the human health standards.
[1] Units are mg/L unless otherwise noted (metals are dissolved concentrations).
[2] Data from November 1996 to November 2005.
[3]NA = not analyzed, removed from monitoring plan.

North Fork Little Dog Creek. Groundwater monitoring in North Fork Little Dog Creek began in 1989 at TMW-15. This well was replaced by TMW-15B in 1993 due to construction of the Horseshoe Waste Rock Dump (Figure 3-1). Both wells were or have been typically dry or contain too little water to sample.

Dog Creek. CR Kendall has occasionally monitored domestic water wells and springs developed for stock water located in the Dog Creek drainage. [Locate data and summarize]

3.5 Vegetation Resources

In the general vicinity of the permit boundary, outside the disturbed areas, the dominant vegetation types consist of evergreen and deciduous forests and grasslands with some mixed forests. Downgradient of the site, small grains, fallow (crop land which has been allowed to lie idle or to restore soil moisture), and pasture lands become increasingly more important.

The 1989 EA included a full inventory of the vegetation types occurring at the mine site. These included three grassland communities, eight forest communities, and the Historic mining disturbance community (over 1,000 acres within the permit boundary are disturbed).

No plants listed as endangered or threatened under the Endangered Species Act are known to be present in the vicinity of the permit boundary.

Noxious weeds such as leafy spurge and knapweeds have been identified in some rangeland areas of Fergus County (USDI 1992); all are spreading as in other areas of Montana. Noxious weed control has been conducted during mine life, but Canada thistle and houndstongue continue to expand on the site. These weeds are common throughout the region, and it would be difficult to determine the seed source. Seeds are spread by wind or carried by animals. Noxious weed control will be addressed as part of the revegetation plan for each alternative.

3.6 Wildlife and Fisheries Resources

The 1989 EA provided a summary of the types of wildlife in the area and their habitat. The habitat in the area of the mine is considered to be of good quality, and prior to mining commencement in 1984, there was considerable recreational use for turkey, grouse, and deer hunting. Anecdotal evidence also identified elk herds and a single black bear in the area of the mine. Other wildlife noted in the project vicinity includes mule and white-tailed deer, antelope, mountain lion, sharp-tailed grouse, pheasant, and gray partridge (among others).

The Draft Environmental Checklist completed by DEQ in 2001 cited only mule deer as being populous in the area. This document also states that “peregrine falcons were introduced to the mine site with the hope that they would nest on the pit highwalls. It appears none have remained.” (DEQ 2001)

The 1989 EA addressed fisheries with the statement that there was no evidence of fish in any streams draining the permit area, but that Little Dog Creek showed evidence of past beaver use. The larger question to be posed is the location and status of any fisheries located in receiving waters of the streams that drain the permit area.

No threatened or endangered species are known to exist in the vicinity of the permit boundary. Biological surveys of the area in 1984 and 1988 did not identify any federally threatened or endangered species.

3.7 Air Resources

The U.S. Environmental Protection Agency (EPA) has established maximum concentrations for pollutants that are referred to as the National Ambient Air Quality Standards (NAAQS). Six “criteria pollutants” are used as indicators of air quality: ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead. The U.S. EPA has designated areas around the country that do not meet these standards as “nonattainment areas.” Areas are designated as attainment or nonattainment for each criteria pollutant. Fergus County is in attainment for all criteria pollutants (40 CFR 81.327).

3.8 Socioeconomics

US Census Bureau 2000 Decennial Census data were reviewed for the vicinity of the mine permit boundary. The mine falls within Block Group 1 (BG1) of Census Tract 301, which covers the northwest corner of Fergus County. In general, the socioeconomic makeup of BG1 is comparable to the State of Montana and Fergus County. The majority of the population is white; the State of Montana has a higher percentage of Native Americans than Fergus County or BG1. Age groups are also comparable, although Fergus County has a slightly higher percentage of senior citizens than Montana or BG1.

Economic data reveal that BG1 has an unemployment percentage of just 1.17%, compared to Fergus County (5.32%) and Montana (6.26%). While median household income is comparable across the three geographies, Fergus County and BG1 report slightly lower incomes than Montana (about 10% lower), while the income per person in BG1 is lower than that for Fergus

County or Montana. The poverty rate in BG1 is higher than Fergus County or Montana at 19.72% - one-fifth of the population of the Block Group lives below the poverty rate.

The US Census Bureau provides information on county business patterns for 2006. The industries identified as having the highest number of employees in Fergus County include:

- Health Care and social assistance (24%)
- Retail trade (16%)
- Accommodation & food services (15%)
- Construction (10%)
- Manufacturing (10%)

Mining in Fergus County accounted for less than 1% of the total number of employed persons.

3.9 Cultural Resources

A comprehensive survey for cultural resources was conducted in 1989 by GCM Services of Butte, MT. No prehistoric resources were identified. Two historic resources were located: the historic townsite of Kendall and the historic Kendall mines and explorations.

The Kendall townsite is located outside of the permit boundary. The only impact considered to this resource was visual/aesthetic impacts. Since the town came into being as a direct result of mining activity, it was determined that current and future mining activity would not negatively impact the resource.

The historic Kendall mines and claims were recorded, mapped, and photographed. No further work was recommended for this resource.

3.10 Visual Resources

Narrow valleys and steep rugged slopes characterize the terrain. The permit boundary encompasses much of the headwaters of Last Chance and Little Dog Creeks. Elevations range from 4,400 feet on the valley floor to 5480 feet on the mountain slopes. As shown in Figure 1-2, much of the land within the permit boundary has been deforested and/or stripped of vegetation. However, reclamation activities have restored grass to the waste rock dumps and other disturbed areas.

A prominent feature of the site is the high walls of the pits, particularly that of the Muleshoe Pit, which can be seen from the access road near Hilger. Vistas can be seen from the mine site itself, particularly looking north from the high ground on the north side of the Horseshoe Pit.

Chapter 4
Environmental Consequences

The impacts analysis will consider both positive (beneficial) and negative (adverse) impacts resulting from each of the alternatives on the existing conditions. Many of the impacts will apply to all of the alternatives, while some will be unique to a given alternative. In order to avoid redundancy, the impacts that are common to all alternatives will be discussed first, followed by the unique impacts on each alternative.

4.1 Assumptions

The analysis of impacts will be based on the following assumptions:

- The alternative would be fully implemented as designed. Potential implementability problems will not be considered during the impacts analysis (see Chapter 5 for a discussion of implementability).

- Necessary mitigations for each alternative are assumed to occur at the time of the action, such that only the net impacts that would occur following all mitigations will be evaluated. An example would be the use of sedimentation BMPs (mitigations) during construction activities.

4.2 Land Use

Adverse impacts to land use are not anticipated. The purpose of the Proposed Action is to reclaim disturbed lands; thus, the impacts of the project will be beneficial. The post-operation land use objectives defined in Chapter 3 would be met by the Proposed Action.

4.3 Geology and Soil Resources

4.3.1 Economic Geology

A potential impact of partial pit backfilling is placing barren rock on top of potentially valuable ore resources. As the economic potential of an ore deposit is evaluated in part on the ratio of overburden that must be removed to get to the ore, backfilling could have an adverse impact should the deposit ever be mined in the future.

4.3.2 Soil Resources

Soil impacts result from removing, storing, and replacing soils during mining. Impacts may include loss of soil development, soil erosion from the disturbed areas and stockpiles, reduction of favorable physical and chemical properties, reduction in biological activity, and changes in nutrient levels. These impacts determine, in part, the potential success of restoring the areas to grazing land and wildlife habitat. Limited reclamation success may result in secondary and long-term negative impacts, including soil erosion followed by sediment entering streams, reduced soil and site productivity, visual deterioration, and seasonal air pollution increases due to wind erosion.

The use of soil stockpiles for reclamation activities (i.e., capping of waste rock, covering of liners, reclaiming disturbed areas, etc.) will consume soil resources, but will not be irreversible, as the soils could be stripped and re-used in the future.

Pit Wall Stability

All of the alternatives employ partial pit backfilling, leaving up to about 350 feet of exposed highwall (Muleshoe Pit). Fill slopes are subject to mass wasting when placed at the angle of repose (the natural slope achieved when material is end dumped), but are generally much more stable when graded to 2:1 slopes or less. As all alternatives include grading pit backfill, mass wasting should not be a concern. Exposed highwalls are subject to isolated short-term rock falls. Evidence of a slump is present on the highwall of the Barnes-King Pit, which occurred during active mining operations (Glenn Pegg Personal Communication), but no recent pit wall stability problems have been observed.

4.4 Water Resources

Impacts to water resources will vary by alternative, as discussed below.

4.4.1 Effects of the Proposed Action on Water Quality and Quantity

The quality and quantity of water resources would be improved by implementing the Proposed Alternative. The following positive impacts would result:

- Nearly complete elimination of the heap leach pads as a source of low-quality leachate due to installation of an FML cover (see HELP modeling results in Appendix B). The predicted water quality requiring treatment is presented in Table 4-1.

Table 4-1
Predicted Water Quality and Flows Requiring Treatment under the Proposed Alternative[1]

Parameter	Units	Underdrain	Leach Pad	Combined	WQB-7 Criteria
As	mg/L diss	0.004	**0.241**	0.004	0.018
Selenium	mg/L diss	**0.011**	**0.121**	**0.011**	0.005
Thallium	mg/L diss	**0.026**	**0.807**	**0.026**	0.0017
Nitrate	mg/L diss	5.9	**111.9**	5.900	10
Cyanide	mg/L diss	0.005	**1.09**	0.005	0.0052

[1] Under average flow conditions (13 gpm underdrain flow and 0.01 gpm leach pad flow)
Bold indicates WQB-7 Standard is exceeded

- Discontinuing sustained use of LAD as a primary treatment of leach pad and other low-quality waters would reduce the on-site groundwater recharge. The result would be that less groundwater capture would be required to prevent plume migration.
- Treating extracted groundwater to below WQB-7 criteria, in each drainage, would provide high-quality water to down-gradient users.
- Water augmentation using springs (from above the site) would provide supplemental water to down-gradient users if required.

- Discontinuing the routine use of water supply wells WW-6 and WW-7 would lessen the possibility of reducing water quantities within area springs.

- Thickening the existing RPL caps on the waste rock piles would provide extra water storage that would otherwise leach thallium from the drain layer and require treatment.

- Removing the accessible historical tailings from off-site locations in BK Gulch and Little Dog Creek would reduce the source of low-quality leachate to groundwater and provide a relatively uncontaminated channel to receive treated mine waters.

- Lining of losing ditches (ditches that loose water by infiltration) with clay amended soil would reduce the amount of water entering the waste rock piles and add relatively high-quality storm water to area drainages.

4.4.2 Effects of Alternative 1 on Water Quality and Quantity

- Lining the waste rock piles would potentially decrease the volume of pump-back water requiring treatment. However, lining the waste rock may not completely eliminate leachate production within the dumps. Drilling within the waste rock piles indicated that a low permeability layer exists beneath the waste rock, which limits the vertical infiltration of leachate into groundwater (Appendix A). Therefore, water flow in the horizontal direction (along the upper surface of the low permeability layer) is favored over vertical infiltration (through the low permeability layer). Under such conditions, recharge produced up-gradient of the waste rock liners could be conveyed along the low permeability layer into the waste rock. While leachate generation within the waste rock dumps may be less than for the other alternatives, treating shallow groundwater would likely remain. In other words, plume control measures could not be discontinued because the source of leachate would not be completely eliminated.

- The other impacts listed for the Proposed Alternative would apply to Alternative 1 as well.

4.4.3 Effects of Alternative 2 on Water Quality and Quantity

- Alternative 2 would have the same impacts as for the Proposed Alternative, with the exception of the near elimination of the leach pad leachate. Under Alternative 2, leach pad leachate would be produced at an average rate of 4 gpm and a peak flow of 19 gpm (based on HELP modeling presented in Appendix B). The predicted water quality requiring treatment under Alternative 2 is presented in Table 4-2.

Table 4-2
Predicted Water Quality and Flows Requiring Treatment under Alternative 2[1]

Parameter	Units	Underdrain	Leach Pad	Combined	WQB-7 Criteria
As	mg/L diss	0.004	**0.241**	**0.058**	0.018
Selenium	mg/L diss	**0.011**	**0.121**	**0.036**	0.005
Thallium	mg/L diss	**0.026**	**0.807**	**0.205**	0.0017
Nitrate	mg/L diss	5.9	**111.9**	**30.219**	10
Cyanide	mg/L diss	0.005	**1.09**	**0.254**	0.0052

[1] Under average flow conditions (13 gpm underdrain flow and 4 gpm leach pad flow)
Bold indicates WQB-7 Standard is exceeded

Comment [HS23]: DEQ-7?

4.4.4 Effects of the No Action Alternative on Water Quality and Quantity

The No Action Alternative would result in the following impacts:

- Less infiltration into the heap leach pad than currently exists. But not nearly as low of an infiltration rate as provided by an FML cover (as in the Proposed Alternative).
- The sustained use of LAD as a primary treatment technology for heap leach water will eventually reduce the quality of groundwater.
- The 2:1 slopes on the Kendall Dump are too steep to provide a stable RPL cover, which will result in continued erosion and poor cover performance.
- Using water supply wells WW-6 and WW-7 may temporarily reduce water quantities in the deep aquifer.
- Leachate from off-site tailings will continue to contaminate groundwater
- Water from unlined ditches will continue to enter the waste rock, resulting in additional water treatment.

4.5 Vegetation Resources

All of the alternatives specify placing soil on and revegetating disturbed areas. The grasses will provide habitat for some types of wildlife. However, it is not realistic to restore the land to its original pre-mining habitat, as planting of pines and other trees on capped wastes would result in penetration of the caps by the tap roots of the trees.

Adverse impacts to vegetation are not anticipated. Conversely, the establishment of vegetation will contribute to a reduction in noxious weed species.

4.6 Wildlife and Fisheries Resources

All of the alternatives specify placing soil on, and revegetating, disturbed areas. The impact should be beneficial, since grassy slopes will replace areas currently consisting of barren ground or waste. The grasses will provide habitat for some types of wildlife. However, it will not be realistic to restore the land to its original pre-mining habitat, as planting of pines and other trees on capped wastes would result in penetration of the caps by the tap roots of the trees.

Fisheries and aquatics were not raised as issues during scoping. The only fisheries issue identified during mine life concerned a fish kill at the Boy Scout Pond in South Fork Last Chance Creek in July 1995? (CITATION). DEQ investigated potential sources of sediment and metal contamination to the pond. DEQ could not determine whether the arsenic levels in sediment were related to current or historic mining operations or natural background levels (DEQ inspection report April 13 and 14 1998, any water protection bureau inspection reports? Ken Kapsi). [CHECK] FWP concluded that the fish kill was due to oxygen depletion due to stirring up of the pond by the storm surge (CITE FWP memo). Any potential impacts to fisheries and aquatics that are identified would be disclosed in the water resources analysis (see Section 4.4).

4.7 Air Resources

As discussed in Chapter 3, Fergus County is in attainment of National Ambient Air Quality Standards. Reclamation of the project area would not contribute to increased levels of any of the six criteria pollutants that are regulated by EPA.

No air quality issues have been raised during mine operation or during the scoping process. Dust control would continue as conducted throughout the life of the mine. Reclamation of the remaining acreage would further reduce potential sources of dust. Equipment emissions would be similar to operational levels during reclamation activities, but would cease when reclamation was completed.

4.8 Socioeconomics

The US Census 2000 data indicate that BG1 includes an environmental justice population consisting of low-income persons. However, the proposed project will not cause disproportionate adverse impacts to this population for several reasons:

- Reclamation will provide aesthetic improvements.
- Reclamation will provide improved land use options for disturbed areas, and is likely to increase recreational uses.
- Reclamation will address water quality and quantity, which would be beneficial to private property owners.

As discussed in Chapter 3, mining accounts for less than 1% of the employed persons in Fergus County. Two of the top three industries listed are Retail Trade and Accommodation and Food Service, both of which would benefit from reclamation and a post-operation land use that supports recreational uses. The Proposed Action would provide positive effects to the socioeconomic situation of Fergus County.

4.9 Cultural Resources

Reclamation proposed by CR Kendall would only occur in areas that have been previously disturbed by mining activities. These areas were investigated and reported in the 1989 GCM report. There would be no impacts to cultural resources within the proposed reclamation area.

No impacts are expected to cultural resources that lie outside the permit boundary. If any work is identified that would occur outside of the previously surveyed area, the area would be investigated for cultural resources. Coordination with the Montana SHPO will be continued if previously uninvestigated areas will undergo reclamation activities.

4.10 Visual Resources

All of the alternatives specify placing soil on, and revegetating, disturbed areas. The impact on visual resources would be beneficial, since grassy slopes will replace areas currently consisting of barren ground or waste.

4.11 Evaluation of Restrictions to Private Property

The Private Property Assessment Act (MCA 2.10.101 – 105) requires that state agencies must assess the impacts of their actions upon private real property. As stated in MCA 2-10-102 – Purpose:

> It is the policy of this state that a person may not be deprived of the use of private property without due process of law and that private property may not be taken or damaged by a state agency without prior just compensation to the owner…

Section 2-10-104 of MCA requires the Montana Attorney General to develop guidelines, including a checklist, to assist agencies in determining whether an agency action has taking or damaging implications.

(once the MPDES permit application has been submitted and the results of water treatment testing by CR Kendall are provided, this assessment can be conducted – statement will be needed along the lines of:

> *The MPDES permit restricts the volume of effluent discharged by the mine in accordance with the water quality act. Discussion of water treatment options)*

4.12 Cumulative Effects

Construction of the BLM access roads and logging activities on BLM land could potentially have a cumulative effect on area road traffic and dust levels, particularly if the construction/logging activities coincide with the construction associated with the site remediation.

4.13 Unavoidable Adverse Effects

Unavoidable adverse effects are defined as those that meet the following:

- There are no reasonably practicable mitigation measures to eliminate the impact.
- There are no reasonable alternatives to the proposed project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar significant adverse impacts.

No unavoidable adverse impacts have been identified for any of the alternatives.

4.14 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources is defined as the loss of future options. It applies primarily to non-renewable resources, such as minerals or cultural resources, and to those factors that are renewable only over long time spans, such as soil productivity.

Irretrievable commitments represent the loss of production, harvest, or use of renewable resources. These opportunities are foregone in the period that the Proposed Action is being implemented, during which other resource utilization cannot be realized. These decisions are reversible, but the utilization opportunities foregone are irretrievable.

No irreversible or irretrievable commitments of resources have been identified for any of the alternatives. Nothing in the Proposed Action would obligate any resources that are irretrievable (i.e., capping of ore reserves would not render them irretrievable; they could still be mined at a later date).

Chapter 5
Comparison of Alternatives and Proposed Alternative

A summary of the four alternatives based on the previously described selection criteria is presented in Table 5-1.

Table 5-1
Comparison of Alternatives Based on the Selection Criteria

Alternative	Effective?[1]	Significant Negative Impacts?	Implementable?	Failure Consequences	Reliable?	Cost Effective?
Proposed Alternative	Yes	No	Yes	Minimal	Yes	Moderate
Alternative 1	Yes	No	Yes	Minimal	Yes	**Poor**
Alternative 2	Yes	No	**No**[3]	**Severe**	Yes	**Moderate-Poor**
No Action Alternative	Yes	**Yes**	Yes	**Severe**	**No**[2]	Good

[1] Effectiveness refers to the ability of the component to meet the project goals, as outlined in Section 1.5 (see section 2 for a discussion of effectiveness).

[2] The main reliability problem associated with the No Action Alternative is the use of LAD for the lowest quality waters on the site. LAD is dependant on the adsorption by soils to be effective, and this is only a temporary process. Other reliability problems include the stability of the current waste rock RPL caps, especially the steeply sloping Kendall Dump.

[3] The main implementability problem is associated with treatment of high loading leach pad water within the small area available for treatment.

Note: Bold indicates a negative attribute

5.1 Effectiveness

Effectiveness for each alternative was discussed in Chapter 2. In general, all of the alternatives, with the exception of the No Action Alternative, are effective. The goals specified in Chapter 1 were met. Note that effectiveness refers to the alternative as a whole and not to individual components of an alternative. For example, placing an FML cover over the waste rock (as in Alternative 1) would result in less leachate being generated than for a water balance cap (as in the Proposed Alternative). However, when water treatment is considered, the alternatives are equally effective. In Alternative 1, the water treatment systems would be slightly smaller than for the Proposed Alternative (due to the lower flows), but the net result would be the same; clean water exiting the site, limited infiltration to groundwater, etc.

5.2 Negative Impacts

The only alternative to have significant negative impacts is the No Action Alternative. The adverse impacts include the sustained use of LAD as a primary treatment method and the poor cap stability on the steep slopes of the Kendall Waste Rock Dump.

5.3 Implementability

Alternative 2 is the only alternative with potential implementability problems, paticularly with respect to water treatment. Alternative 2 specifies placing a water balance cap on the heap leach pads, which results in an average flow of 4 gpm and a spring peak flow of about 19 gpm. A summary of the predicted water quality for the under-drain and leach pad water for the Proposed Alternative and Alternative 2 are shown in Tables 4-1 and 4-2, respectively.

Note that in Alternative 2, treating nitrate, cyanide, and arsenic is required, while in the Proposed Alternative only selenium and thallium treatment is required.

In addition, the concentration of thallium to be treated under alternative 2 is 10 times higher than for the Proposed Alternative. Selenium concentrations for Alternative 2 are three times higher than for the Proposed Alternative. The higher concentrations (and loadings) for Alternative 2 result in poor performance for an adsorption-based treatment system. First, the residence time (contact time between the media and the water) must be much greater for a system receiving high concentrations than for a system receiving relatively low concentrations. A larger treatment system is needed because of the high residence time requirement. In addition, the higher concentrations result in much faster saturation of the adsorption sites on the media, which results in frequent media replacement or backwashing. CR Kendall has had little success treating leach pad water using zeolite adsorption media due to the poor performance and residence time requirements involved. For additional discussion of the water treatment evaluation see Appendix D. While it is technically possible to treat leach pad water under this scenario, the following issues will make long-term, reliable treatment difficult for this water:

- Chemical feed systems will need to be re-filled and maintained through regular inspections to ensure proper dosing and operation. This will be especially difficult in winter months.

- Chemical feed systems will require power to operate, which is not currently available at all of the treatment system locations.

- Biological treatment systems do not respond well to fluctuations in flow, water quality and temperature, making nitrate removal difficult on long-term, continuous basis.

Treatment cell life will be significantly reduced due to the relatively high load of contaminants compared to the other drainages.

5.4 Failure Consequences

Failure consequences are particularly severe for Alternative 2 and the No Action Alternative. For example, should the water treatment system in Mason Canyon fail, very low-quality water would be released off-site until the flow from ponds 7 and 8 could be turned off. However, if the treatment system for Mason Canyon under the Proposed Alternative should fail, which is less likely, the magnitude of the release would be a fraction of that under Alternative 2.

Should the water balance caps, specified in the Proposed Alternative fail, the precipitation (rain or snow melt) would reach the drain rock layers. The result would be the treatment of additional flows (collected from the drain layers) for thallium, which could be accomplished by adding cells to the treatment systems. Failure of the clay layers in the RPL caps, as in the No Action Alternative, would result in infiltration of precipitation into the waste, leachate creation, and an adverse effect on groundwater (in the case of the waste rock dumps). Failure of the RPL on the heap leach pads would result in increased production of very low-quality leachate (see Table 4-2), which would require treatment by LAD. Should the LAD treatment fail (under the No Action Alternative), which will happen eventually, the low-quality water will adversely affect the groundwater quality. Under such a scenario, the pump-back water quality would begin to decline.

5.5 Reliability

The main reliability problem for the No Action Alternative is associated with the sustained use of LAD as a primary treatment process. As mentioned previously, it is not a matter of if LAD will stop working, but when. Other reliability issues relate to the ability of the Kendall Dump to hold the existing RPL cover, especially on the 2:1 sloping southeast flank. Erosion will tend to thin the cap on the steep slopes and the vegetation will be adversely affected. The loss of vegetation will in turn result in increased erosion and so forth.

5.6 Cost

Based on the analysis so far, Alternative 1 and the Proposed Alternative are equivalent with respect to all criteria. However, the costs associated with Alternative 1 are significantly higher. The cost of placing an FML cover on 56 acres of heap leach pads (as in the Proposed Alternative) is approximately $4 million. To place an FML cover on 56 acres of heap leach pads and 157 acres of waste rock would cost over $15 million.

Chapter 6
Consultation and Coordination

Early attention to consensus building generally allows the project to proceed smoothly by assuring that stakeholders have an opportunity to voice their concerns and to be part of the overall decision making process. The SIP gathers stakeholder input using various components of the scoping process (see below).

The following scoping activities were completed between February and June 2003 as part of the scoping process for the Kendall EIS:

- Public Interviews
- Scoping Document
- Open House
- Public Meeting
- Technical Meetings

6.1 Public Interviews

As part of the scoping process, CDM held private interviews for the interested public in Lewistown, Montana. The purpose of the interviews was to collect input of interested community members on issues related to the mine, thus providing valuable background information for the completing the EIS. CDM solicited all input (technical or non-technical, positive or negative). No attempt was made to validate the accuracy or completeness of the statements made by the respondents.

The interviews were held on March 10 and 11, 2003 from 8:00 am to 6:00 pm and from 8:00 am to 3:00 pm on March 12. The interviews were promoted in a flyer that was sent to the 135 postal patrons of the Hilger post office (see Scoping Report for a list of recipients). CDM also prepared a press release that was approved by DEQ and released to local media and the Associated Press. The Lewistown News Argus printed a small story on the interviews in the March 7 edition. The local radio station aired announcements in its local news the week prior to the interviews and on the Tuesday and Wednesday of the interviews. Individuals who could not attend the meetings were encouraged to call and be interviewed over the telephone.

The interviews were widely advertised to ensure that all interested parties would have an opportunity to participate. The format was a private interview at a neutral location (the Yogo Inn in Lewistown). This format was chosen to encourage participation by people who might be uncomfortable or afraid to speak in a public meeting.

Twenty-five people were interviewed as part of this process. The length of each interview ran from 15 to 75 minutes, depending on the person being interviewed. Three other individuals came in to discuss the project, but did not participate in interviews. Two additional people

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were interviewed over the telephone, and comments from one individual were received by e-mail.

CDM recorded the name of each interviewee on an attendance sheet and took notes of each interview on blank sheets of paper. The interviewee's name was not included in those notes. Each interviewee was asked a series of eight questions, previously approved by DEQ:

- Are you familiar with the proposed reclamation of the CR Kendall Mine? If so, please tell us how you obtained your information and how familiar you feel (very, somewhat, not very).
- What are your concerns regarding the property, and is one more important than another?
- What do you think are the key issues for the communities of Lewistown or Hilger? How would you rank those issues?
- Would you like to be involved in the technical meetings?
- Are you interested in learning more about the EIS and/or in getting updates on progress?
- Do you have a preference regarding who should provide these updates? If so, please tell us which source you would prefer.
- What do you think is the best way to communicate with the public about the work being done (fact sheets, public meetings, newspaper ads, radio, web site)?
- Do you want to be on the mailing list to receive additional information?
- Where do you think we should hold public meetings?

Attendees were also encouraged to "speak their mind" while CDM took notes. The notes were used to construct this summary after the interview process was finished.

Interviewees included people living near the mine property and other local residents. Seven of the interviewees stated that they either currently or previously worked at the CR Kendall mine or had relatives who did. Others had no history with the mine. Nineteen of the interviewees were local ranchers. Nine of the respondents were involved in an ongoing lawsuit against CR Kendall. Most respondents were long-time or lifetime residents of the area. Many of these people had been on the mine property for recreational purposes before Canyon Resources began its operations.

In brief, responses to most questions (other than Question 2) were straightforward. Many people believed they had some degree of familiarity with the reclamation of the site. Several people wanted to participate in the technical meetings. Most people thought Lewistown was the best place to hold public meetings. Everyone interviewed wanted to be added to the mailing list to get updates about the project, and they wanted those updates to come from the contractor.

Question 2 elicited highly polarized opinions on many subjects, especially those related to water quantity, water quality, and cost. Almost all respondents named water quality and quantity as concerns regarding the property. Response was divided on which was more important. Some respondents also listed other issues such as aesthetics and safety, cost, DEQ response, water treatment, and land application disposal (LAD) of mine water.

The information obtained in the public interviews is discussed in Section 4 of the Scoping Report (CDM, 2004a). The following provides a brief summary of the types of statements made in response to Question 2 by topic area.

- ***Water Quality Concerns and Related Issues.*** Statements were made regarding the quality of the mine water, the willingness of local ranchers to use mine water for irrigation and stock watering, contamination from the mine affecting off site properties, potential water treatment techniques, ways to avoid water treatment, the potential for acid mine drainage, historic mine tailings in local creeks, the leach pads, and overburden dumped in canyons.

- ***Water Quantity Concerns.*** Statements were made regarding the mine's role in reducing the amount of water available off site, water quantity problems attributed to the mine that the interviewees thought were really the result of the long-term drought and evidence of that drought at local properties, the mine's settlements or attempted settlements with local ranchers, the pump-back system, local drainage, water piping, well pumping, the lack of forward movement on reclamation, water rights, and uses of mine water.

- ***Aesthetics and Safety.*** Statements were made on the aesthetics of the mine highwalls, the need for a return to pristine conditions, the overall improvement of appearance since CR Kendall took over the mine, noxious weeds, and the safety hazard the mine pits pose to children and others.

- ***Cost, Funding, and Related Issues.*** Statements were made regarding who should pay for the EIS and mine reclamation, ways to hold down costs, and whether cost should be included or excluded as an issue in the EIS.

- ***DEQ Response and Participation.*** Statements were made relating to the public's dissatisfaction with DEQ because of favoritism towards the mine or favoritism towards certain landowners, plus DEQ's community involvement.

- ***Other.*** Statements were made regarding the desire for adequate reclamation, LAD, land ownership, land use, mining industry regulation, the reclamation bond, the need for public tours, the need for compromise, and the mine as a good neighbor.

6.2 Scoping Document

A scoping document was prepared and distributed prior to the open house and public meeting. The scoping document included the following topics:

- Opportunities for public involvement.

- CR Kendall mine history.
- Relationship of drainage basins to mine pits.
- Overview of the EIS process.
- Issues of concern.
- Discussion of EIS alternatives.
- EIS deliverables.
- Sources of additional information.

The scoping document was reviewed and approved by DEQ prior to being finalized. It was distributed by mail to over 100 individuals on the DEQ provided mailing list on March 29, 2003.

6.3 Open House

The open house was held at the Yogo Inn in Lewistown from 4:00 pm to 6:00 pm on April 9, 2003. An advertisement was prepared by CDM and approved by DEQ for publication in the Lewistown News Argus. The ad ran four weeks, two weeks, three days, and one day prior to the event.

The format was agreed upon with DEQ prior to the event. Five tables, each representing a particular topic, were set up in a large meeting room. Each table was staffed by one or more CDM, TetraTech (ttEMI), or DEQ employees with posters, maps, or other materials that illustrated their topic.

Individual topic areas and their respective representatives were:

- Water quantity - Darrel Stordahl, P.E. (CDM) and Brian Goodman (ttEMI).
- Water quality – Randy Huffsmith, P.E. (CDM).
- Mine Reclamation – Ed Surbrugg Ph.D. (ttEMI).
- EIS Process – Kathy Johnson (DEQ).
- Kendall Mine Regulatory History – Pat Plantenberg (DEQ) and Wayne Jepson (DEQ).

Twenty-eight people registered on the sign in sheet for the open house, although a few more attended without signing in. Attendees were encouraged to move freely from table to table, depending upon their interests. During discussion with the technical representative at each table, notes of the discussions were recorded on a flip chart for use in summarizing the event.

6.4 Public Meeting

The public meeting was also held on April 9, 2003 at the Yogo Inn in Lewistown, from 6:30 pm to 7:45 pm, in the same room as the open house. The ad that ran in the Lewistown News Argus for the open house also advertised the public meeting.

The format of the two-part meeting was agreed upon with DEQ prior to the event. CDM started the meeting with a 30-minute PowerPoint® presentation that introduced the EIS team and discussed the scope of the EIS, history of the mine, and potential remedial alternatives.

Following the presentation, CDM opened the meeting for public comment. The rules of public comment were explained to the audience, and individuals who had indicated on the sign in sheet that they wanted to provide comment were called to the front of the room in the order they appeared on the sign in sheet. After all those who had signed up had an opportunity to speak, the floor was opened to any other interested parties. Participants were given three minutes each to provide their comment, and no one required that length of time. All comments were recorded by a court reporter.

Approximately 28 people attended the public meeting and seven people provided comment. Several people provided written comments a few weeks following the meeting. Several people who signed up to comment changed their minds and declined to do so or left early. The meeting was orderly and people were respectful of one another. By 8:00 pm all comment had been provided and the meeting was adjourned.

6.5 Technical Meetings

CDM facilitated a series of working meetings with technical specialists and stakeholders. These meetings were held to allow those who were interested to become more involved in the technical aspects of the EIS. At the public interviews, open house, and public meeting attendees were asked if they were interested in participating in the technical meetings. Recipients of the Scoping Document were also advised that they should contact CDM if they were interested in participating in the meetings. A total of 20 people indicated that they had some interest in participating in the meetings. Individuals who indicated they were interested in participating in the public meetings were notified by letter of the dates and topics of the meetings.

Each technical meeting was organized around primary interests based on the comments provided in the public interviews, open house, and public meeting. Participants discussed significant concerns identified during the scoping process and explored ways to address those concerns.

The meetings were held as follows:

- Monday, May 29, 2003 – This meeting took place in Lewistown and was focused on reclamation issues.
- Tuesday, June 3, 2003 – This meeting was also in Lewistown and focused on water quality and quantity issues.

- Thursday, June 12, 2003 – This impromptu meeting took place in Helena at the request of one of the prior technical meeting attendees and was focused on developing reclamation components for evaluation in the EIS.

- Thursday, June 26, 2003 – This meeting was held in Lewistown and focused on developing reclamation alternatives for evaluation in the EIS.

Technical meetings were moderated by a CDM or ttEMI staff member. Issues raised during the technical meeting were added to the list of issues gathered from other scoping activities and are discussed in Section 4 of the Scoping Report (CDM, 2004). The information gained was used to further refine issues and potential alternatives. This allowed effective public and stakeholder involvement.

As part of the SIP, CDM assisted DEQ in compiling important EIS-related documents for an information repository. This will include all fact sheets and newspaper articles, as well as copies of the draft and final EIS. Additional details on public involvement and the SIP can be found in the Scoping Report (CDM, 2004a).

Chapter 7
List of Preparers

Name and Title	Company	Project Responsibility
Kent Whiting Geochemist Project Manager	CDM	Project Management, Geochemical Evaluations and Water Treatment
Darrel Stordahl, P.E. Mining/Environmental Engineer	CDM	Technical Review and QA/QC
Brian Goodman, P.G. Geologist	CDM	Geology and Hydrogeology
Robert Kimball, P.E. Chemical Engineer	CDM	Water Treatment
Karen Ekstrom, P.G. Geologist	CDM	Public Relations
Randy Huffsmith, P.E. Agricultural/Water Resources Engineer	KirK Environmental, LLC	Capping and Drainage
J. Edward Surbrugg, Ph.D. Soil Scientist	ttEMI	Capping, Vegetation, and Soils
Alice Stanley, P.G. Hydrologist/NEPA Specialist	ttEMI	EIS Structure

Chapter 8
Glossary of Terms

Adsorption	Transfer of a dissolved constituent from solution onto the surface of a solid (such as soil particle).
Angle of Repose	The maximum slope or angle at which loose material remains stable. Commonly ranges from 33 to 37 degrees on natural slopes.
Armored Ditch	Ditch with a gravel and cobble bottom
Bank Cubic Yards	The volume of soil when present in the ground. After excavation, the soil swells about 30% and is referred to as loose cubic yards.
Best Management Practice (BMP)	DEQ and EPA approved measures used to control sediment discharge from a site.
Breccia	A coarse-grained rock, composed of angular broken rock fragments held together by a mineral cement or a fine-grained matrix.
cation exchange capacity	The capacity for a soil to exchange positively charged ions (cations) adsorbed onto the surfaces of the soil grains with cations dissolved in a solution in contact with the soil. Soils with high cation exchange capacity are generally fine-grained as they have more surface area for ion exchange to occur than for coarser materials.
Cover	A low permeability or impermeable material which is placed *over* wastes to prevent or minimize infiltration of rain water or snow melt water into wastes. While liners and covers can be identical materials, covers are placed *on top of* wastes, while liners are placed *below* wastes.
Ephemeral	A stream which flows briefly in direct response to precipitation and whose channel is above the water table.
Evapotranspiration	The sum of evaporation and transpiration (evaporation of water through plant leaves).
Flexible Membrane Cover	An impermeable, man-made, cover material, such as polyvinyl chloride (PVC) or high density polypropylene (HDPE).
Karst	A type of topography that is formed over limestone by dissolution, and that is characterized by sinkholes, caves, and underground drainage.
Leachate	Water (often low quality) which is generated when rain water or snow melt comes into contact with wastes.

Liner	A low permeability or impermeable material which is placed *below* wastes to prevent leachate from migrating into groundwater. While liners and covers can be identical materials, covers are placed *on top of* wastes, while liners are placed *below* wastes.
Porphyry	An igneous rock of any composition that contains large visible grains within a fine-grained groundmass.
SPLP	A test which is performed on soils in which a synthetic rainwater is placed in a bottle along with a measured soil amount and agitated for 18 hours. The water is then drained from the soil and analyzed for the constituents of concern.
Syenite	An igneous rock (solidified from molten rock) containing feldspars, dark minerals (like hornblende) and very small amounts of quartz.
Water Balance Cover	A soil cover designed to hold infiltration water (in the pore spaces) long enough for evapotranspiration to remove the water and limit deep percolation into the wastes below.
Zeolites	A natural mineral used to adsorb contaminants and remove them from water. Zeolites are porous and have high surface areas, which increases the adsorption of contaminants compared to many other materials.

Chapter 9
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Executive Summary

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1.0 Introduction

1.1 Purpose of and Need for the Proposed Action

1.2 Reclamation Plan Background

1.3 Public Involvement

1.4 Key Issues

1.5 Issues Eliminated From Further Consideration

2.0 Summary of the Proposed Action

2.1 Objectives of the Proposed Action

2.1.1 Primary goals

2.1.2 Secondary goals

3.0 Affected Environment (short discussion of the affected areas only)

4.0 Environmental Consequences (short discussion of the affected areas only)

5.0 Mitigation Measures

6.0 Conclusion (includes next steps, public hearing, Final EIS production, decision)